US ARMY CORPS
OF ENGINEERS
GREAT LAKES AND OHIO RIVER DIVISION
LOUISVILLE DISTRICT

MILL CREEK, OHIO, FLOOD CONTROL PROJECT

A BRIEFING DOCUMENT FOR THE GENERAL REEVALUATION REPORT

REPORT ON THE INITIAL SCREENING OF ALTERNATIVES

MARCH 2003
REVISED JULY 2003

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
P.O. BOX 59 ATTN: PM-C
LOUISVILLE, KENTUCKY 40201-0059

MILL CREEK, OHIO, FLOOD CONTROL PROJECT

A BRIEFING DOCUMENT FOR THE GENERAL REEVALUATION REPORT

REPORT ON THE INITIAL SCREENING OF ALTERNATIVES

MARCH 2003
REVISED JULY 2003

INITIAL SCREENING REPORT

SYLLABUS

EXECUTIVE SUMMARY

This report documents the initial screening of alternatives for the Mill Creek, Ohio, Flood Control Project as part of the Corps of Engineers (Louisville District) efforts to complete a General Reevaluation Report for the project. The Mill Creek, Ohio, Flood Control Project has a long history, beginning with a reconnaissance and feasiblity report in the late 1960s. Following these studies, the Mill Creek, Ohio Flood Damage Reduction Project was authorized by the Flood Control Act of 1970 to provide flood damage protection along approximately 17.5 miles of the Mill Creek in Hamilton County, Ohio. Features of the authorized project included channel modifications such as widening and paved lining, two miles of levees, three pumping stations, modifications to highway and railroad bridges, addition of two pumping units at the existing Barrier Dam Pump Station, and various recreational features. Project construction began in 1981 and continued over 10 years. However, in 1991, then-Assistant Secretary of the Army (Civil Works), Nancy Dorn suspended the project pending a full review – due to inflated project costs, the presence of hazardous materials and contamination, as well as other complications. At this point, about 40-50% of the original authorized project was completed.

Project direction varied from termination to reevaluation until a cost-sharing agreement was made in 1998 to prepare a General Reevaluation Report (GRR). The need for additional funding and a suspension of work funds in 2000 led to further delays. In November and December 2000, "visioning sessions" were held with the communities and stakeholder agencies to solicit public input on future development of the Mill Creek basin. Local groups, particularly the Metropolitan Sewer District (MSD) of Greater Cincinnati, advanced the concept of a deep tunnel which would carry both excess storm water (from Mill Creek) and combined sewers overflow (CSO). Such an alternative would avoid surface construction problems in brownfield areas, and would also solve serious pollution problems in Mill Creek due to the numerous CSOs which empty into the creek. In mid-2001, the Louisville District prepared a ***Bridging Document*** – so-called because it was intended to be a "bridge" between early formulation efforts (1996-2000), and wishes of the community as expressed in the visioning sessions. The ***Bridging Document*** recommended focusing the GRR strictly on the tunnel alternative, since other alternatives were considered "unacceptable" by the Sponsor and local groups. However, additional Corps guidance in late 2001 directed that "the study must consider appropriate structural and non-structural alternatives" as necessary to identify the plan which maximizes National Economic Development (NED) benefits, which will serve as the basis for cost sharing for a Locally Preferred Plan.

In early 2002, Louisville District developed a four-stage study plan to complete the GRR analysis. Technical work actually began following a letter in April 2002, from the Assistant Secretary of the Army (Civil Works), prompting the effort to expedite completion of the Mill Creek, Ohio, Flood Control Project GRR.

An array of ten alternatives has been evaluated and compared during 2002 Stage 1 studies. This evaluation began with the following six alternatives:

- Without-Project (WO)
  For the most part, the Mill Creek would be left as-is. The WO alternative (or No-Action alternative) was used as the basis of comparison for the other plans. Limited ecosystem restoration and provision of certain recreational facilities along portions of the Creek's riparian corridor will likely be undertaken in the future through programs and grants initiated by the Mill Creek Restoration Project (MCRP) or other local groups.

- Total Relocation (RL)
  This alternative consists of relocating all structures in the 4% chance ("25-year") floodplain. Utilities and structures remaining in the floodplain would be demolished to ground level, and basements would be filled. Street pavement would also be removed.

- Non-Structural (NS)
  This alternative consists of protecting selected high value/damage facilities with ring levees and relocating all other structures in the 4% chance ("25-year") floodplain. As with the RL alternative, remaining structures outside the ring levees would be demolished, and basements filled.

- Channel Modification (CM)
  This alternative consists of modifying the channel to complete the construction of the channel which was designed per the currently authorized plan, as described in the 1975 General Design Memorandum (GDM), with the addition of a few features to assure protection from the 1% chance ("100-year") flood event through Mill Creek and the East Fork (in Hamilton Co.).

- Floodwall (FW) and Levee
  This alternative consists of floodwalls and levees in the remaining uncompleted sections (4B, 5, 6, 7A, 7B, 7C, and 8) of the channel to provide protection from the 1% chance ("100-year") flood event.

- Deep Tunnel (TU)
  This alternative consists of constructing a deep tunnel (approximately 31 feet in diameter and 200-300-feet deep) along the length of Mill Creek in Hamilton County to handle a portion of the flood flows. The tunnel would also provide capacity to handle CSOs for up to a 50% chance ("2-year") storm event. The TU alternative would provide flood protection from the 1% chance ("100 -year") flood event.

After a preliminary review of data for the above alternatives, it was decided that three additional alternatives should be evaluated:

- Non-Structural 2 (NS-2)
  This alternative is the same as NS but without buyouts or relocation. Only ring levees would be utilized for protection of 25 high-value/high-damage facilities. Structures remaining outside the ring levees would not be protected.

- Channel Modification 2 (CM-2)
  This alternative consists of completing the 1975 Authorized Project utilizing environmentally sustainable design features.

- Deep Tunnel 2 (TU-2)
  This alternative consists of the construction of a deep tunnel approximately half the length of the tunnel in the TU alternative. The TU-2 would serve the upper portion of the study area and discharge at the point of the existing improved channel. This alternative would provide no relief to CSOs, but virtually the same overbank-flood protection as the TU alternative.

In February 2003, a tenth alternative was added for consideration. The addition of this alternative allowed for direct comparison with the surface structural and tunnel alternatives, both of which offer flood damage protection to the 1% chance event:

- Non-Structural 3 (NS-3)
  This alternative is similar to the NS alternative but with the increase of protection for the entire 1% chance ("100-year") floodplain.

This screening-level document outlines and evaluates the above ten alternatives and provides a very preliminary assessment of the impacts associated with their individual implementation. This analysis will lead to the selection of two or three alternatives that will be evaluated in greater detail during later stages of the GRR evaluation.

The following table summarizes the economic results of the With-Project alternatives (based on a 2010 project base year):

Alternative	Average Annual Benefits	Average Annual Costs	Benefit to Cost Ratio	Annual Net Benefits
Total Relocation (RL)	$53.7 m	$44.3 m	1.21	$9.5 m
Non-Structural (NS)	$49.9 m	$38.4 m	1.30	$11.5 m
Non-Structural 2 (NS-2)	$40.4 m	$10.6 m	3.82	$29.8 m
Non-Structural 3 (NS-3)	$53.4 m	$61.4 m	0.87	(-$8.0 m)
Channel Modification (CM)	$49.4 m	$32.1 m	1.54	$17.3m
Channel Modification 2 (CM-2)	$49.4 m	$44.9 m	1.10	$4.6 m
Flood Wall & Levee (FW)	$44.5 m	$38.2 m	1.16	$6.3 m
Deep Tunnel (TU)	$48.2 m	$51.7m	0.93	(-$3.5 m)
Deep Tunnel 2 (TU-2)	data undergoing revision for TU-2			

Notes: for comparison purposes the benefits and costs are presented for a 2010 project base year; discount rate of 5.875%; 50-year project life; price levels are for 2002 dollars.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

ITEM **PAGE**

TABLE OF CONTENTS (cont'd)

ITEM **PAGE**

TABLE OF CONTENTS (cont'd)

ITEM **PAGE**

TABLE OF CONTENTS (cont'd)

ITEM **PAGE**

APPENDICES

LIST OF FIGURES

ITEM **PAGE**

LIST OF TABLES

ITEM **PAGE**

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

ITEM **PAGE**

LIST OF ACRONYMS AND ABBREVIATIONS

BCR	Benefit to cost ratio
CAGIS	Cincinnati Area Geographic Information System
CELRD	Corps of Engineers, Lakes & Rivers Division (Cincinnati)
CELRL	Corps of Engineers, Lakes & Rivers Division, Louisville District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response Compensation, and Liability Information System
CM	Channel Modification Alternative
CM-2	Channel Modification 2 Alternative
CSO	Combined Sewers Overflow
DEIS	Draft Environmental Impact Statement
FEIS	Final Environmental Impact Statement
EPA	Environmental Protection Agency
ER	Engineering Regulation
FDA	Flood Damage Analysis
FEMA	Federal Emergency Management Agency
FIA	National Flood Insurance Administration
FW	Floodwall/Levee Alternative
FWS	Flood Warning System
GDM	General Design Memorandum
GEC	Gulf Engineers & Consultants
GIS	Geographic Information System
GRR	General Reevaluation Report
HEC	Hydraulic Engineering Center
HQ	Headquarters
HTRW	Hazardous, toxic, and radioactive waste
IPR	In-Progress Review
ITR	Independent Technical Review

LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

LCA	Local Cooperation Agreement
LRD	Lakes and Rivers Division
MCRP	Mill Creek Restoration Project
MCWC	Mill Creek Watershed Council
MG/yr	Million gallons per year
MWH	Modified Warmwater Habitat
MSD	Metropolitan Sewer District
MSL	Mean sea level
MVCD	Millcreek Valley Conservancy District
NED	National Economic Development
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
NS	Non-Structural Alternative
NS-2	Non-Structural 2 Alternative
NS-3	Non-Structural 3 Alternative
NWI	National Wetlands Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PED	Planning, Engineering, and Design
PMP	Project Management Plan
PSP	Project Study Alternative
RCRA	Resource Conservation and Recovery Act
RL	Total Relocation Alternative
ROW	Rights-of-way
SACCR	Schedule and Cost Change Request
SCS	Soil Conservation Service
SHPO	State Historic Preservation Office

LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

SPT	Standard Penetration Test
TDS	Total Dissolved Solids
T&E	Threatened and endangered
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TU	Deep Tunnel Alternative
TU-2	Deep Tunnel 2 Alternative
TWA	Time Weighted Average
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WO	Without-Project Alternative
WSO	Weather Station Office

1. PROJECT AUTHORITY AND COST-SHARING AGREEMENTS

1.1 PROJECT AUTHORIZATION

In June 1965, the Committee on Public Works for the U.S. House of Representatives adopted a resolution directing a study for flood control and other allied purposes in Mill Creek Basin, Ohio. This was followed by two additional resolutions in May 1967 and October 1967 by the Committee on Public Works for the U.S. Senate and U.S. House of Representatives, respectively, directing studies to consider a comprehensive plan of development in Southwestern Ohio, including improvements for flood control.

As a complete response to the June 1965 resolution and a partial response to the 1967 resolutions, the Chief of Engineers submitted an interim survey report to the Secretary of the Army in 1970 for transmission to Congress. The interim survey report recommended the development of various channel improvements and levees intended to provide a level of flood protection for a 1% chance ("100-year") flood event along approximately 17.5 miles of Mill Creek in Hamilton County, Ohio and along the ¾ mile length of East Fork in Hamilton County (refer to Figure 1.1.1 for a general overview map of the study area and to Appendix VI for more detailed mapping). The recommended plan would provide for a series of channel modifications, such as widening, deepening, and paved lining, in combination with the construction of levees, landfills, and pumping stations along certain stretches of the creek; the modification of bridges, roads and sewer systems; the addition of pumping units to the Mill Creek Barrier Dam; and the development of various recreational features.

Congress authorized the Mill Creek, Ohio Flood Damage Reduction Project in Section 201 of the Flood Control Act of 1970 (P.L. No. 91-611) approved December 31, 1970. The authorization provided as follows:

> Sections 201 and 202 and the last three sentences of Section 203 of the Flood Control Act of 1968 shall apply to all projects authorized in this title. The following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted by the Secretary of the Army, acting through the Chief of Engineers in the respective reporter hereinafter designated . . .
>
> OHIO RIVER BASIN
>
> The flood protection project on Mill Creek, in Ohio, is hereby authorized, substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 91-413, at an estimated cost of $32,642,000.

Design and real estate acquisition work began in the early 1970's, and construction began in 1981. Construction continued until 1991 (with only four of the 11 sections completed and two other sections partially completed), when the Assistant Secretary of the Army (Civil Works) suspended all work on the project until a full review of the project could be made.

INSERT FIGURE 1.1. Location Map

In 1994, a Plan of Study was developed for a General Reevaluation Report (GRR), to evaluate the feasibility of completing all or parts of the project. The project fluctuated from termination to reevaluation from then until 1997, when the decision was made to reevaluate the project and prepare a GRR. (More details on the history and chronology of the project are provided later in Sections 2, 3 and 4.)

The current evaluation effort is a continuance of the authorized Mill Creek, Ohio, Flood Damage Reduction Project. The effort's goal is to complete the GRR and make recommendations for further improvements and/or for the long-term maintenance of management of the Mill Creek. In all probability, many of the alternatives considered in this report would require congressional review and approval prior to implementation.

1.2 LOCAL SPONSOR AGREEMENTS

A Local Cooperation Agreement (LCA) was executed between the U.S. Army Corps of Engineers (USACE) and the local sponsor, Millcreek Valley Conservancy District (MVCD), for the flood damage reduction work to be completed under the Mill Creek Flood Damage Reduction Project in 1975. Under the LCA for flood control, MVCD assumed responsibility to:

? Provide without cost to the United States all lands, easements, and rights-of-way (ROW) necessary for the construction of the project.

? Hold and save the United States free from damages due to the construction works.

? Maintain and operate all the works after completion in accordance with the regulations prescribed by the Secretary of the Army.

? Provide without cost to the United States all modifications and relocations of buildings, utilities, streets, footbridges, sewers, and related and special facilities as necessary for the construction of the project.

? Prevent encroachment on improved channels and on ponding areas, which would impair capacities.

An LCA for recreation was also executed in 1975 under which MVCD assumed responsibility to pay 50% of the costs of recreational development and to maintain and operate the recreational areas and facilities upon completion.

Two subsequent agreements were entered into in connection with the GRR that the USACE Louisville District was directed to initiate on the project. The Department of the Army, the MVCD, the City of Cincinnati, Ohio, and the Village of Evendale entered into a GRR Cost Sharing Agreement in 1998. The Department of the Army and MVCD also entered into an Operation and Maintenance Agreement in 1998 under which MVCD assumed responsibility for operation and maintenance of the project sections upon completion of each section.

2. INTRODUCTION, PURPOSE AND SCOPE OF REPORT

2.1 INTRODUCTION TO THE MILL CREEK FLOOD CONTROL PROJECT

Mill Creek is a 28-mile stream in southwestern Ohio, which drains into the Ohio River in the City of Cincinnati. Much of the creek's length runs through highly developed areas. Historically, Mill Creek has experienced significant flooding, both from backwaters of the Ohio River and from localized rainfall events.

Section 1.1 discussed the actions which authorized the Mill Creek flood control study (as early as 1965), and the interim survey report leading to the authorization of the Creek, Ohio Flood Damage Reduction Project in 1970. Design and real estate acquisition work began in the early 1970's, and construction began in 1981. (See Section 4 for chronological details).

In 1991, with only four of the 11 sections completed and two other sections partially completed, the Assistant Secretary of the Army (Civil Works) suspended all work on the project until a full review of the project could be made. The four reasons cited for the suspension were: (1) project costs had grown from $32 million to a projected $341 million; (2) real estate acquisitions and relocations for the remainder of the project were not yet accomplished, bringing into question whether the local sponsor was committed to the project and capable of fulfilling its financial obligations; (3) hazardous materials could cause contamination; and (4) completed sections were not being operated and maintained by the local sponsor. As actually built, the level of protection along completed sections varies from section-to-section along Mill Creek, but is believed (based on current data) to fall between a 2%- and 1%-chance flood (between the "50-year" and "100-year" flood level).

The project fluctuated from termination to reevaluation between 1992 and 1997. Ultimately, the decision was made to reevaluate the project and prepare a GRR. A cost-sharing agreement for the GRR was executed in 1998, in addition to an Operation and Maintenance (O&M) Agreement for the completed sections. Originally, this effort was to conclude in October 2000 with the GRR.

In late 2000, a series of public meetings (Visioning Sessions) were held with the communities and stakeholder agencies to solicit public input on future development of the Mill Creek basin. (A report summarizing the Visioning Sessions, prepared by the contractor who facilitated these sessions, is included in this report as Appendix II.) In June 2001, the ***Mill Creek, Ohio Flood Damage Reduction Project Bridging Document*** was published to help bridge past evaluation efforts and the "way-ahead." It was intended that the ***Bridging Document*** would include the USACE Louisville District's recommendation for completion of the GRR in connection with public opinion of what type of flood damage reduction project would be acceptable. The ***Bridging Document*** recommended that the GRR focus only on various designs for a deep-tunnel, which would solve both flooding problems along Mill Creek as well as problems with combined sewer overflows (CSOs). A deep tunnel would also avoid surface construction which could be complicated by the numerous industrial "brownfields" and/or the presence of hazardous and toxic waste along the streambanks after over 150 years of intense industrial activity. At this point, a deep-tunnel was the locally preferred plan.

In November 2001, review memos on the ***Bridging Document*** were received from both the USACE's Lakes and Rivers Division (LRD-Cincinnati) and from USACE's Headquarters (HQ). These memos recommended replacing the old Memo of Agreement with the Sponsor with a design agreement specifying 75% Federal and 25% non-Federal cost sharing--consistent with current USACE policy. The memos further specified that the GRR should evaluate a wide array of both structural and non-structural alternatives to provide flood reduction and solve other problems along Mill Creek. (A more detailed year-by-year chronology of the history of this project is presented in Section 4).

In order to complete the GRR in keeping with the Nov.2001 LDR and USACE HQ guidance, an array of 5 With-Project alternatives and a revised evaluation process was developed by the USACE Louisville District study team between December 2001 and March 2002, and coordinated with LRD and USACE HQ representatives, and with the project Sponsor and other local stakeholders. The five With-Project alternatives included:

? Plan RL – total relocation of structures within the 4% chance event ("25-year") floodplain.

? Plan NS – plan similar to RL, but certain high-damage structures would be protected by ring-levees or other flood-proofing measures.

? Plan CM – complete the channelization of Mill Creek, providing protection along Mill Creek up to the 1% chance ("100-year") level of protection, using a design very similar to that developed by the USACE in the 1975 General Design Memorandum (GDM) and subsequent Feature Design Memoranda.

? Plan FW – use primarily levees and floodwalls to provide protection along Mill Creek up to the 1% chance ("100-year") flood level.

? Plan TU – construct a deep 16-mile long tunnel (plus other measures) to protect Mill Creek up to the up to the 1% chance ("100-year") level. This tunnel would incidentally also provide a significant reduction to CSO problems along the creek through the provision of some sewer drop-shafts, various connections to the sewer system, and connections to the Cincinnati sewage treatment plan at the downstream end of the considered tunnel. The plan has been developed to a reconnaissance level-of-detail by the Metropolitan Sewer District of Greater Cincinnati (MSD) and their consultant Parsons-Brinkerhoff.

Between December 2002 and February 2003, following coordination with LRD, it was decided that four variations (primarily of the NS and CM plan) also be considered. Hence, this report will summarize the findings of nine With-Project alternatives and one Without -Project which serves as a baseline.

In order to evaluate the alternatives in an effective and timely manner, a four-stage study process was developed and coordinated in early 2002. In April 2002, this process was formalized into a revised working draft Project Management Plan (PMP) in April 2002. On October 15, 2002, after various revisions, the current working PMP was published and signed by the Sponsor and Study Team partners. The four-stage process is:

Stage 1: Initial screening of an array of alternatives.
Stage 2: Optimization of two final plans.
Stage 3: Final detailed studies leading to a draft GRR and DEIS.
Stage 4: Final coordination and report generation (final GRR and FEIS).

2.2 SCOPE & PURPOSE

The purpose of the entire GRR process leading to a final GRR report is to provide a complete technical, environmental and economic assessment of flood reduction alternatives for the Mill Creek Study Area. The purpose of **this** document is to provide a "mid-course" screening-level report which will provide decision-makers (including local stakeholders and USACE's higher authority) information on the results of the Stage 1 analyses, as conducted between April 2002 and February 2003. This report is primarily intended to be a technical report to assist the decision-makers, and is not intended for mass distribution. This report should not be construed as a preliminary GRR as it may lack certain discussions or figures that would be appropriate in a more formal document.

2.3 SCOPE OF THIS INITIAL SCREENING REPORT

This Initial Screening of Alternatives Report is intended to offer comparisons among the array of nine With Project alternatives. This screening-level analysis was based largely, although not exclusively, on the development of the following for each plan:

? Design layouts using the latest available mapping of the study area.

? Assessment of O&M features and costs.

? Potential for hazardous and toxic waste concerns during construction.

? Preliminary construction schedule.

? Identification of significant biological and cultural resources in the study area, and preliminary analysis of potential impacts to these resources.

? Screening-level evaluation of costs and benefits.

It was intended per the PMP that (following review of this report) an In-Progress Review (IPR) Conference would be held for the purpose of deciding which of the nine With-Project alternatives would be carried forward. At a minimum, the IPR would include the Sponsor, local stakeholders, study team leaders, and LRD and HQ-USACE officials.

2.4 CRITERIA FOR ALTERNATIVE'S COMPARISON

A goal of the evaluation and comparison process was to evaluate each alternative against two sets of criteria. According to USACE Engineering Regulation (ER) 1105-2-100 for planning criteria, a project in a Feasibility or GRR report must be analyzed with regard to the following four criteria:

- ? *Completeness* – Does the plan include all necessary parts and actions to produce the desired results?
- ? *Effectiveness* – Does the alternative meet the objectives to some degree? How does it stack up against constraints?
- ? *Efficiency* – Does the plan minimize costs? Is it cost effective?
- ? *Acceptability* – Is the plan acceptable and compatible with laws and policies?

Although the above four criteria are the current and official USACE criteria for plan evaluation, an old list of criteria from previous editions of ER1105-2-100 has also been used in the course of the GRR evaluation to-date. This "old list" stipulates that plans developed in the course of USACE's studies must be:

(1) economically justifiable,
(2) environmentally sustainable,
(3) publicly acceptable,
(4) engineeringly feasible.

This "old-list" of criteria was widely discussed between team members and local stakeholders during the ***Visioning Sessions*** and during development of the set of nine With-Project alternatives. Therefore, although there is some overlap in meaning between the "old list" and the current four criteria, both were used in this report for comparison, particularly in the summaries of Section 11. (At the upcoming IPR, LRD and HQ may provide guidance on exactly which criteria to use or emphasize in the later final GRR.)

2.5 STUDY PARTICIPANTS

Study participants are grouped into three major categories and subcategories as shown below:

TECHNICAL STUDY

- ? USACE, Louisville District (overall technical management)
- ? USACE, Chicago District (economics studies)
- ? U.S. Fish and Wildlife Service (Reynoldsburg, OH field office)
- ? U.S. Environmental Protection Agency (Region 5, Chicago)
- ? Ohio Environmental Protection Agency (OEPA)
- ? Environmental and Engineering Consultants

PRIMARY LOCAL INTERESTS (Stakeholders)

- Millcreek Valley Conservancy District (MVCD) – Local Sponsor
- Metropolitan Sewer District of Greater Cincinnati (MSD)
- Mill Creek Watershed Council (MCWC)
- Mill Creek Restoration Project (MCRP)
- Ohio, Kentucky, Indiana Regional Council of Governments (OKI)
- Rivers Unlimited

INDEPENDENT TECHNICAL REVIEW (ITR)

- USACE, Nashville District (ITR lead and Planning ITR)
- USACE, Louisville District (most engineering disciplines and economics ITR)
- USACE, Chicago District (structural design ITR)

3. PRIOR STUDIES AND REPORTS

3.1 GENERAL

The Mill Creek Valley Flood Protection Project has been ongoing for approximately four decades, and many reports, reviews, and assessments have been written. The following documents are currently available. This is not, however, an exhaustive list of every document written over the life of this project.

USACE, Louisville District, *Report of Sedimentation Survey, West Fork Mill Creek Reservoir, Ohio*, October 1962.

USACE, Louisville District, *Plan of Survey for Review Report of Survey Scope on Mill Creek Basin, Hamilton and Butler Counties, Ohio, for Flood Control and Allied Purposes*, February 1966, revised April 1967.

Public Hearing for Consideration of Flood Control and Allied Purposes on Mill Creek, Cincinnati, Ohio, 18 January 1968.

Southern Butler County Conservancy District, Butler Soil and Water Conservation District, Hamilton Soil and Water Conservation District, Butler County Board of Commissioners, *Watershed Work Plan, Upper Mill Creek Watershed, Butler and Hamilton Counties, Ohio*, September 1968.

Public Hearing for Consideration of Improvements for Flood Control on Mill Creek, Cincinnati, Ohio, 23 January 1969.

USACE, Louisville District, *Interim Survey Report on Mill Creek in Southwestern Ohio for Flood Damage Reduction and Recreation*, January 1970.

USACE, Louisville District, *Mill Creek Environmental Study*, 1972.

USACE, Louisville District, *Mill Creek Local Flood Protection Project, Ohio River Basin, Mill Creek, Hamilton and Butler Counties, Ohio, Design Memorandum No. 1, Hydrology and Hydraulics*, February 1973.

USACE, Louisville District, *Phase I – Plan Formulation, General Design Memorandum, Mill Creek Local Flood Protection Project, Ohio River Basin, Mill Creek, Hamilton and Butler Counties, Ohio, Design Memorandum No. 2*, April 1974.

USACE, Louisville District, *Appendix 1 to Phase I – Plan Formulation, General Design Memorandum, Mill Creek Local Flood Protection Project, Ohio River Basin, Mill Creek, Hamilton and Butler Counties, Ohio, Design Memorandum No. 2, Appendix 1, Recreation Resource*, April 1974.

Final Environmental Impact Statement, Mill Creek Local Protection Project, Cincinnati, Ohio, April 1974.

USACE, Louisville District, *Phase II – Project Design, General Design Memorandum, Mill Creek Local Flood Protection Project, Ohio River Basin, Mill Creek, Ohio, Design Memorandum No. 3*, March 1975.

USACE, Louisville District, *Appendix 1, Recreation Resource, Phase II – Project Design, General Design Memorandum, Mill Creek Local Flood Protection Project, Ohio River Basin, Mill Creek, Ohio, Design Memorandum No. 3,* March 1975.

USACE, Louisville District, *Mill Creek Local Flood Protection Project, Ohio River Basin, Design Memorandum No. 4, Concrete Aggregate and Stone Protection Sources,* April 1976.

USACE, Louisville District, *Report of Sedimentation Survey, West Fork Lake, Ohio, 1975, Sedimentation Resurvey Supplement No. 2 to Design Memorandum No. 3,* August 1976.

USACE, Louisville District, *Mill Creek Local Flood Protection Project, Mill Creek, Ohio, Design Memorandum No. 5, Railroad Relocations,* February 1977.

Ohio, Kentucky, Indiana, Regional Council of Governments (OKI), *Regional Water Quality Management Plan,* June 1977.

USACE, Louisville District, *Mill Creek Local Flood Protection Project, Ohio River Basin, Mill Creek Ohio, Section 7A, Design Analysis,* December 1977.

USACE, Louisville District, *Mill Creek, Ohio, Local Protection Project, Section 3 and 4, Master Plan, Design Memorandum Number 6,* March 1984.

USACE, Louisville District, *Design Memorandum No. 6, Barrier Dam Pumps, Mill Creek Local Flood Protection Project, Ohio River Basin,* August 1984.

USACE, Louisville District, *Draft, Mill Creek, Ohio, Local Flood Protection Project, Master Plan for Public Use, Design Memorandum Number 7,* March 1990.

Contamination Assessment, Mill Creek Section 9, 1 August 1990.

Mill Creek, Ohio, Local Protection Project, Contamination Reconnaissance Report, November 1990.

Mill Creek, Ohio, Local Protection Project, Section 4B, Subsurface Characterization and Contamination Assessment Report, January 1991.

USACE, Louisville District, *Mill Creek, Ohio, Local Flood Protection Project, Master Plan for Public Use Design Memorandum No. 7,* August 1991.

Thomas A. Stitt, P.E., P.S. and Woolpert, *Final Report Estimated Flood Protection Benefits, Millcreek Valley Conservancy District*, July 30,1993.

Ohio Environmental Protection Agency (EPA), Division of Water Quality Planning and Assessment, *Biological and Water Quality Survey of Mill Creek (Butler and Hamilton Counties, Ohio*), August 25,1993.

USACE, Louisville District, *Plan of Study, Mill Creek, Barrier Dam-Forebay Sedimentation Study, Ohio, Reconnaissance Stage Study,* November 1993.

USACE, Louisville District, *Environmental Site Assessment for 11 Soil Disposal Areas at the Mill Creek, Ohio Local Protection Project, Phase 1,* January 1994.

OKI, Ohio, Kentucky, Indiana Regional Council of Governments, *Mill Creek Watershed Management Plan, Butler and Hamilton Counties, Ohio,* July 1995.

Ross, *Economic Analysis*, June 1997.

USACE, Louisville District, *Mill Creek, Ohio Flood Damage Reduction Project; General Reevaluation Report Project Study Plan*, December 1997.

Mill Creek, Ohio, Levee Inspections Report, LFPP, 6 February 1997, updated 24 June 1997, 2nd update April 1998.

USACE, Louisville District, *Sampling and Analysis Report, Part 2, Mill Creek, Ohio, Section #3*, November 1998.

Altech Environmental Services, *Field Observation & Study Report*, 1998 and 2001.

Fuller, Mossbarger, Scott, and May, Greenways Incorporated, Biohabitats, Inc., *The Mill Creek Watershed Greenway Masterplan*, June 1999.

Gulf Engineers & Consultants (GEC), *Mill Creek Flood Control Project, Hamilton County, Ohio, Summary Report Sections 2, 4B, 5, and 6, Environmental Design Constraints*, October 2000.

Ohio EPA, *Total Maximum Load Implementation Plan for Mill Creek,* December, 2001. US Army Corps of Engineers, Louisville District, *Millcreek Flood Management Plan, Meeting Summary [Visioning Sessions]*, prepared by Moore Iacofano Goltsman, Inc. (Berkeley), Jan. 2001.

US Army Corps of Engineers, Louisville District, *Mill Creek, Ohio Flood Damage Reduction Project, Bridging Document,* June 2001.

American Rivers, http://www.amrivers.org/mostendangered/Mill Creek1996.htm, November 2002.

Ohio EPA Division of Surface Water, Laws and Rules, *Mill Creek Drainage Basin,* http://www.epa.state.oh.us/dsw/rules/01-30.pdf, November 2002.

U.S. Department of Agriculture, Soil Conservation Service, *Work Plan for Watershed Protection and Flood Prevention, Upper Mill Creek Watershed, Butler and Hamilton Counties, Ohio.*

USACE, Louisville District, *Mill Creek, Ohio Flood Protection Reduction Project – Bridging Document,* June 2001.

USACE, Louisville District, *Mill Creek, Ohio Flood Protection Reduction Project – Project Management Plan,* 15 October 2002.

Ohio Department of Natural Resources, U.S. Geological Survey (USGS) Maps, 2002. US Army Corps of Engineers, Louisville District, DRAFT *Mill Creek, Ohio Flood Control Project, Hamilton Co., Ohio, Summary Report, Environmental Design Constraints,* prepared by GEC (Baton Rouge), January 2003.

US Army Corps of Engineers, Louisville District, *DRAFT Study Area Literature Review and Pedestrian Phase I Archaeological Reconnaissance of 488 Acres Adjacent to the Mill Creek Flood Damage Reduction Project, Hamilton Co., Ohio,* prepared by Gray & Pape (Cincinnati), January 2003.

4. SUMMARY OF COORDINATION, PUBLIC COMMENTS

4.1 PROJECT HISTORY

The following provides a chronological review of the Mill Creek Project and events that have led to the reanalysis of the GRR effort and the project:

- 1959 – Severe flooding occurred in the Mill Creek watershed.
- 1962 – The MVCD was created to represent public corporations in the watershed.
- 1962-1970 – USACE performed reconnaissance and feasibility studies.
- 1970 – The project was authorized by the Flood Control Act of 1970 (PL 91-611). The project would provide a 1% chance event level of flood protection and consisted of 17.5 miles of channel modifications that included widening, deepening, and realigning the creek, constructing two miles of levees and three pumping stations, modifying highway and railroad bridges, adding two pumping units at the existing Mill Creek Barrier Dam, and including various recreational features along the mainstem of Mill Creek in Hamilton County.
- 1975 – A LCA was executed with the MVCD to construct the authorized project.
- 1975 – The GDM was completed, providing detailed design information on the project and dividing the project into eight sections (see Figure 4.1.1). Two of the sections were subdivided at a later date for a total of 11 sections.
- 1975 – An Agreement for Recreation Development was executed with the MVCD.
- 1976-1980 – Detailed design continued, and real estate acquisition by MVCD was underway.
- 1981 – Construction of Section 7A was initiated. The channel grade was left approximately three feet above the final grade in an effort to reduce flooding downstream. Final excavation of this section was to be done along with a cleanup of the entire channel after all other channel sections were completed.
- 1983, March – Construction of Section 3 was initiated and construction of Section 7A was completed.
- 1984, June – Construction of Section 2 was initiated. Completion of this section was delayed due to a slide that occurred during construction along I-75 and Ludlow Avenue.
- 1984 – Construction of Section 3 was completed.
- 1986, May – Construction of Section 4A was initiated.
- 1986, December – A contract was awarded to install two additional pumps at the Barrier Dam.
- 1988, November – A separate contract was awarded for repair of the slide in Section 2.
- 1989, August – Construction of Section 1 was initiated.
- 1989, December – Construction of Section 4A was completed; construction of Section 2 and the slide repair were completed.
- 1991, August – Completion of a Master Plan for the recreation features.
- 1991 – Installation of the two pumps at Barrier Dam was completed.

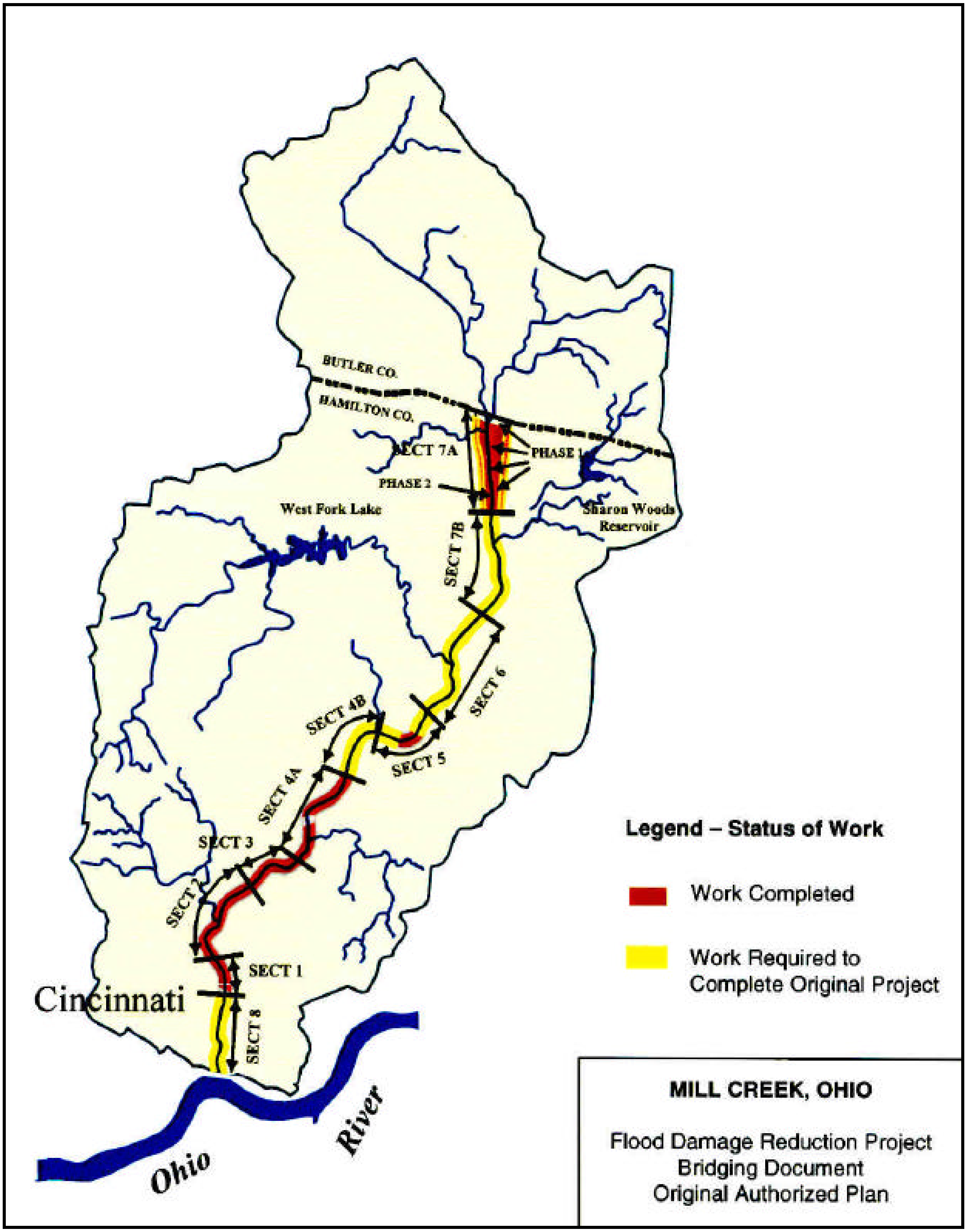


Figure 4.1.1. Mill Creek Channel Sections

- ? 1991 – All design efforts and future project construction were suspended at the direction of the Assistant Secretary of the Army (Civil Works) based on an August 1991 report prepared by Robert G. Eiland.[1] All ongoing construction work was allowed to continue to completion.
- ? 1993, December – Construction of Section 1 was completed.
- ? 1994 – A plan of study was developed for a GRR.
- ? 1995-1996 – Negotiations with the MVCD for the GRR were tied to reaching an agreement on the operation, maintenance, and turnover of the completed sections. Terms of the agreements could not be settled with the MVCD.
- ? 1996 – USACE Civil Works Directorate determined that the Louisville District should proceed with a Termination Study instead of a GRR.
- ? 1996-1997 – The MVCD conveyed its acceptance of O&M responsibilities to USACE, and terms of the agreements were settled.
- ? 1997, June – An Economic Analysis Summary, including flood damage estimates, existing levee analysis, and annual benefits calculations, was completed by the Louisville District.
- ? 1998 – A Contributed Funds Agreement for the GRR was executed in August with the MVCD, City of Cincinnati, and the Village of Evendale, and the GRR was initiated.
- ? 1998, August – An agreement for the restoration, O&M, and turnover of the completed sections was executed with the MVCD.
- ? 1999, October – The Louisville District determined that additional funding and time would be needed to complete the GRR as described in the approved PSP.
- ? 1999, December – The Louisville District met informally with the Great Lakes and Ohio River Division staff to discuss formulation methods.
- ? 2000, February – The Louisville District held a Special Project Review Board meeting to outline strategy to complete the GRR and to obtain District consensus.
- ? 2000, April – The Louisville District held an IPR meeting with the Great Lakes and Ohio River Division to present a plan for completion of the GRR and the restoration of the completed sections.
- ? 2000, May – The Great Lakes and Ohio River Division Counsel prepared a document that set forth many questions and concerns about this project since 1991.
- ? 2000, July – The Louisville District submitted a Schedule and Cost Change Request (SACCR) for completion of the GRR and the restoration of the completed sections.
- ? 2000, August – A meeting was held between the Louisville District and the Great Lakes and Ohio River Division staff to decide on the way to proceed. It was decided to prepare a Bridging Document, which would include both the Louisville District's recommendation for completion of the GRR and public opinion about an acceptable flood damage reduction project.
- ? 2000, September – Questions from the document prepared by the Great Lakes and Ohio River Division counsel were formalized and received by the Louisville District.
- ? 2000, November and December – Visioning Sessions were held with the communities and stakeholder agencies to solicit public input on future development of the Mill Creek basin.
- ? 2001, June – The Bridging Document was published.
- ? 2001, November – Review memos on the Bridging Document were received from members of the CELRL Internal Review Team and HQ-USACE . Memos recommended replacing the old Memo of Agreement with MVCD with a design agreement specifying 75% federal and 25% non-federal cost sharing, consistent with current USACE policy. Memos also specified

[1] Robert G. Eiland was a consultant for the Assistant Secretary of the Army (Civil Works) in 1991. He was tasked with performing an independent review of the Mill Creek Project for the Army.

that a wide array of both structural and non-structural alternatives to solve flood damage and other problems be addressed in the GRR.

- 2001, November through 2002, February – Negotiation began with HQ-USACE on appropriate steps to complete the GRR and on a list of alternatives to be documented in the GRR report. It was decided on February 12, 2002, at a meeting between Skip Fach (HQ-USACE Planning), Harry Simpson (CELRD), and representatives of CELRL, MSD, and the MVCD that an acceptable study plan would involve a four-stage effort: (1) initial screening of alternatives; (2) optimization of selected alternatives; (3) final detailed studies, including Micro Computer-Aided Cost Engineering System (M-CACES) and report preparation; and (4) final coordination.
- 2002, April – Letter from Assistant Secretary of the Army (Civil Works) with guidance on cost sharing for completion of the GRR (Appendix I).
- 2002, June. Revised Working-DRAFT PMP completed outlining 4-Stage process to complete the GRR.
- 2002, October. PMP published and signed by team and Sponsor.
- 2003, March. Stage 1 computations completed for initial screening of nine With-Project plans.

4.2 PUBLIC VIEWS AND COMMENTS

4.2.1 History – Pre-1998

Community sentiment to the Mill Creek Project has varied throughout the years. Initially, the community supported any plan that would provide protection from, and eliminate loss and damage due to rising floodwaters. Flooding has been a chronic problem on Mill Creek since 1897. Combining flood relief with anticipated recreational enhancements, the community remained supportive and participated as a financial partner (LCAs of 1970). The community's support wavered as the times and concerns of the citizens changed and costs began to increase.

Work on Mill Creek was incomplete and construction ceased in 1991. The public was left with a partially completed, unmaintained channel that offered 50% flood protection in 43% of the area and few recreational improvements or environmentally rebuilt habitats.

4.2.2 Current

Numerous community groups have raised concerns about the impact of completing the Mill Creek Project as authorized. Some concerns voiced were (1) what type of environmental impacts will occur, (2) what considerations will be given to recreational areas, (3) what will be the visual impact to the neighborhoods and, (4) what impacts will occur to the aquatic life along the creek. There is a strong desire to restore water quality, habitat value and recreation access along the Creek.

The tunnel alternative has engendered a great deal of community support. This is based on a perception that a tunnel would provide 1% chance level of flood protection; bypass known and potential hazardous, toxic, and radioactive waste (HTRW) sites; eliminate environmental impact that could be caused by the construction of levees, floodwalls, and channel modification;

prevent sewer backup; and allow treatment of the CSO which now flow directly into Mill Creek on a regular basis following ordinary week-to-week rain events.

4.2.3 Visioning Sessions

In August 2000, as a result of the revised PSP submitted in the July 2000 SACCR, a Project Review Meeting was held with the Great Lakes and Ohio River Division. Discussions during this meeting revealed that the plan being considered did not have full community support, and the stakeholders may not agree on a resolution to problems associated with Mill Creek. Prior to proceeding with the GRR study, the decision was made to seek more input from the community to gauge the limits of a supportable project.

The MCWC conducted the Mill Creek Vision Open House on November 9, 2000 to inform the public of the upcoming visioning sessions and to solicit their input. Appendix II provides the summary report of these meetings. Since the Visioning Sessions, virtually all community interests have supported a multi-purpose tunnel that would serve both water quality (reduction of CSOs) and flood-damage reduction purposes. It may be the only alternative that would be acceptable based on all four USACE's criteria and that also has widespread local stakeholder support.

5. EXISTING CONDITIONS

5.1 DEFINITION OF STUDY AREA

The study area is located in Hamilton County in southwest Ohio. Mill Creek flows from the southeastern part of Butler County in a southerly direction across Hamilton County and through the City of Cincinnati to its confluence with the Ohio River at approximately river mile 472.5. The total fall in elevation of the channel from the headwaters of Mill Creek to the mouth, over a distance of approximately 28 stream miles, is about 250 feet, with an average gradient of 8.9 feet per mile. Refer to Figure 1.1.1 for a general overview map of the study area and to Appendix VI for more detailed mapping.

The Mill Creek basin, has a total drainage area of about 159 square miles and lies in Southwest Ohio is generally bounded by the Miami River basin to the northwest, the Little Miami River basin to the east, and the Ohio River to the south. In the lower portion of the basin, valley walls are steep, rising 200 to 300 feet above the valley floor. Major tributaries within the Mill Creek basin include East Fork Mill Creek, Sharon Creek, Cooper Creek, and West Fork Mill Creek. These tributaries enter Mill Creek at Stations 1961+50, 1834+50, 1747+50, and 1617+00, respectively, with drainage areas of 9.4, 10.5, 6.5, and 36.4 square miles at their mouths. Table 5.1.1 lists drainage areas at various locations along Mill Creek.

TABLE 5.1.1
Mill Creek Basin Drainage Areas

Location	Station	Drainage Area (Sq Miles)
Barrier Dam	1024+00	159
Mitchell Avenue	1318+30	132
Center Hill Road	1422+10	121
Carthage USGS	1557+80	115
Reading USGS	1667+00	73
Glendale Milford Road	1822+00	61
Sharon Road	1886+30	50
Confluence with East Fork	1961+50	42

The lower segment of the Mill Creek floodplain, located primarily in the confines of the City of Cincinnati and surrounding municipalities, is urban in character and is almost totally developed (see Figure 5.1.1). The development consists of a mixture of industry and transportation ranging from light to heavy commercial establishments, including small proprietorships and large corporations. Properties are a combination of commercial and residential. Transportation facilities, including roads, streets, interstate highways, rail track and spur lines, and extensive railroad yards crisscross the area. The upper portion of the watershed in

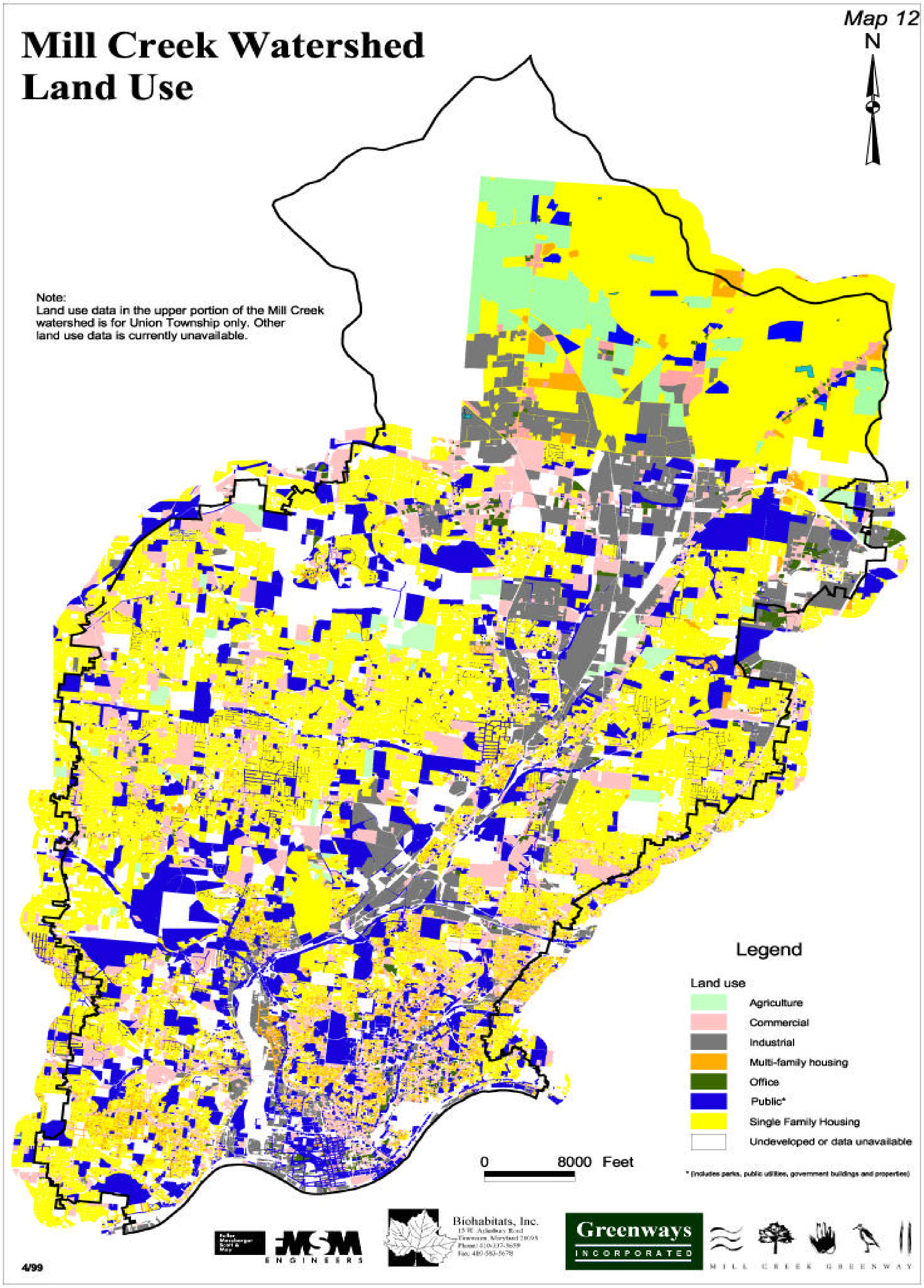


Figure 5.1.1 Mill Creek Watershed Land Use

Butler County is more rural. However, industrial development within the flood plain is starting to occur.

As noted in Section 4.1, channel improvements were constructed along various sections of Mill Creek between 1980 and 1991, to provide protection against Mill Creek headwater flooding in Hamilton County. The design/construction job was so large that the work was divided geographically in "Sections" numbered section 1 (starting at the Western Hills Ave. viaduct) upstream to Section 7 (ending at the Butler Co. line). Later, some of the sections were subdivided: Section 7 was subdivided into Sections 7A, 7B and 7C; and Section 4 was subdivided into 4A and 4B. Finally, the portion of Mill Creek between the barrier dam and Western Hills Ave. was named "Section 8" (although this number is geographically out-of-sequence with the others), resulting in a total of 11 sections. These section names are still being used to refer to portions of the mainstem. A description of each section and the associated construction schedules are provided in Table 5.1.2.

TABLE 5.1.2
Description and Location of Mill Creek Channel Sections

Section	Description	Stream Station	Status
8	Barrier Dam to Western Hills Avenue extends from the barrier dam on the downstream end to Western Hills Viaduct on the upstream end. Total length is approximately 1.5 miles.	102100 to 109980	Not complete
1	Western Hills Avenue to Hopple Street took five years to complete - awarded in August 1989, and completed December 1994. Total length of this section is approximately 1 mile.	109980 to 115000	Complete
2	Hopple Street to Upstream of intersection of Dooley By-pass and Spring Grove Road. This section consists of approximately 2.25 miles of channel improvement extending from just below Hopple Street on the downstream end to Section 3 at Salway Park on the upstream end. Construction of Section 2 began in June 1984. Completion of Section 2 was delayed due to a slide that occurred during construction along I-75 at Ludlow Avenue between Stations 1224+00 and 1232+00. Construction of a wall, designed and constructed to contain the slide area, was awarded by separate contract in November of 1988. Construction of the wall and Section 2 were completed in December 1989.	115000 to 125300	Complete
3	Upstream of intersection of Dooley By-pass and Spring Grove Avenue to Chessie R/R Bridge. Construction of Section 3 began in March 1982 and consists of approximately 1.5 miles of channel improvement extending from Salway Park on the downstream end to the CSX-Transportation Bridge upstream from Mitchell Avenue.	125300 to 134310	Complete
4A	Chessie R/R Bridge to Center Hill Road. This section is approximately 1.5 miles in length, extending from Section 3 at the downstream end to Center Hill Avenue on the upstream end. Construction began in spring 1986.	134310 to 142230	Complete
4B	Section 4B extends from Center Hill Avenue on the downstream end to Vine Street on the upstream end. Total length is approximately 2 miles.	153675 to	Not Complete
5	Section 5 extends from Vine Street on the downstream end to just below Galbraith Road on the upstream end. As part of the Cross County Highway Project, the Ohio Department of Transportation has paved the portion of this section from Station 1576+50 to the end at Station 1607+00 with 8-inch concrete on the bottom and side slopes. Also, a section on the downstream end from Station 1532+00 to Station 1544+00 has been constructed as an earth channel by the State of Ohio under the Cross County Highway Contract. Section 5 has a total length of approximately 1.5 miles.	153675 to 16170	Partially Complete

Section	Description	Stream Station	Status
6	West Fork Mill Creek to Glendale Milford Road extends just downstream from Galbraith Road on the downstream end to Formica Drive on the upstream end. Total length is approximately 3 miles.	161700 to 182255	Not Complete
7B	Glendale Milford Road to Sharon Road extends from Formica Drive on the downstream end to 700 feet north of Sharon Road on the upstream end. No final design work has been done on this section. Total length is approximately 2 miles.	182255 to 188690	Not Complete
7A	Sharon Road to I-275 Construction began on Section 7A in 1981 because of a readily available ROW. To prevent induced flooding downstream of the section, the new channel grade was left approximately 3-4 feet above the final channel grade. Section 7A will be excavated to final grade after all other channel work downstream is completed. No additional ROW is required. Section 7A is the last flood control activity to be accomplished, to be followed by final cleanup. Final cleanup will remove approximately 3 feet of channel grade to the final channel grade and clean up all sections when construction has been completed.	188690 to 195580	Partially Complete
7C	Added after the initial study began. This section runs from I-275 to Hamilton County Line. Total length is less than one mile.	195580 to 200100	Not Complete

Note: Length of study area is 18.56 miles.

5.1.1 Climate

The Metro Cincinnati area has a temperate climate with relatively cold winters and hot, humid summers. The mean annual temperature is 53.9 degrees F, with extremes ranging from about 25 degrees below zero to slightly greater than 100 degrees. Average monthly temperatures range from about 76 degrees F in July to about 30 degrees F in January. Table 5.1.3 shows average monthly temperatures for the Metro Cincinnati area. All seasons are marked by weather changes that come from passing weather fronts and associated centers of high and low pressure.

TABLE 5.1.3
Mean Monthly Temperature (^{O}F)
Cincinnati/Northern Kentucky International Airport
52 Years (1948-1999)

Jan	29.8	Jul	75.7
Feb	33.3	Aug	74.1
Mar	42.2	Sept	67.3
Apr	53.3	Oct	57.7
May	63.2	Nov	43.9
Jun	71.1	Dec	34.1
Annual	**53.9**		

5.1.2 Precipitation

Precipitation in the Cincinnati area is fairly well distributed throughout the year. The annual precipitation averages about 41 inches. The monthly average ranges from 2.65 inches in September to 4.15 inches in May. Table 5.1.4 gives monthly rainfall amounts for the period of record for the Weather Station Office (WSO) located at Cincinnati/Northern Kentucky International Airport. Because of the limited amount and duration of snowfall, snowmelt generally does not contribute significantly to runoff for the Mill Creek basin. Rainfall, which occurs in this basin or parts of this basin, does not necessarily occur in surrounding basins.

TABLE 5.1.4
Mean Monthly Precipitation (inches)
Cincinnati/Northern Kentucky International Airport
(1948-1999)

Jan	3.24	Jul	3.99
Feb	2.84	Aug	3.24
Mar	3.93	Sept	2.65
Apr	3.76	Oct	2.66
May	4.15	Nov	3.23
Jun	4.06	Dec	3.14
Annual 40.89			

5.2 EXISTING FLOOD CONTROL MEASURES

5.2.1 Barrier Dam

Located near the mouth of Mill Creek is the Mill Creek Barrier Dam and Pump Station (see Photo # 24 in Appendix III). The dam and pump station was built in the early 1940's as part of the Cincinnati Local Flood Protection Project. The Barrier Dam was designed to protect Mill Creek from backwater flooding from the Ohio River. The gates of the dam are closed only during flood events along the Ohio River. The pump station was designed to pump high flows from Mill Creek into the Ohio River. Features of the Barrier Dam include:

? A large pumphouse including 6 pumps;

? 1,420 feet of levee and concrete wall between the western abutment of the dam and pump house;

? 5,660 feet of concrete wall to form the eastern closure of the dam.

As part of the Mill Creek Local Protection Project, two additional pumps were added to the Barrier Dam in 1991, making a total of eight with a total capacity varying from 12,400 cfs against a 27.5-foot head to 14,400 cfs at a 5-foot head to the Ohio River.

Comparisons of historical Mill Creek discharge hydrographs at the barrier dam with Ohio River elevation hydrographs at the confluence with Mill Creek were made from water year 1941 to present, including the March 1933 flood event. The March 1933 flood was considered to be approximately equal to the 1% chance ("100-year") flood. Discharge hydrographs at the mouth were obtained from the USGS gaging station discharge data at Carthage and at Reading, and transposed to the mouth by application of a drainage area factor to account for the increased drainage area associated flows. The elevation hydrographs of the Ohio River were obtained from the gaging station in Cincinnati (mile 471.0) transposed to the confluence with Mill Creek. Generally, because of the large difference in drainage area between Mill Creek and the Ohio River, Mill Creek peak flows had already passed through the barrier dam before the Ohio River reached a stage (52 feet) when the gates of the barrier dam would be closed. If the peaks were coincident, the Ohio River never reached this stage with the exception of the March 1933 and March 1945 floods. For these flood events, peak flows of over 17,000 and 16,000 cfs on Mill Creek occurred after the closure of the gates. These floods were studied in detail in 1984 with the design data and results shown in the USACE publication, Design Memorandum No. 6, Barrier Dam Pumps, dated August 1984. For these two coincident floods, a modified pulse storage routing was performed utilizing available storage above the dam site. The maximum interior ponding elevations that would be reached for both floods were slightly less than 479 feet mean sea level (MSL) with the pumps in operation, an elevation that would not cause damage. As stated earlier, an analysis of coincident Mill Creek and Ohio River flooding indicated that the March 1933 flood was equal to a 1% chance flood event.

5.2.2 Private Levees

Several private levees have been constructed throughout the years to prevent or lessen flood damages to industries along the stream. Many of these private levees are located between Glendale-Milford Road and Kemper Road. Industries protected by these levees include Ford Motor Company transmission plant, the General Electric jet engine plant, Aero Blast, Sysco food distributors, General Mills cereal plant, a site previously known as Astro Containers, and other smaller industries. Ford, Aero Blast, and General Mills are all located in Section 7A while the previous Astro Containers and Sysco are in Section 7B. General Electric is located in Section 6.

5.3 SOCIO-ECONOMIC CHARACTERISTICS

Table 5.3.1 provides selected population characteristics for Hamilton County and the State of Ohio. In 2000, the population of Hamilton County was 845,303, which was an 8.5% decrease from 1970 when the Mill Creek, Ohio, Flood Control Project began. The 2000 population density of Hamilton County was 2075.1 persons per square mile, indicating that Hamilton County is a densely populated area.

TABLE 5.3.1
Socio-Economic Characteristics

Characteristic	Hamilton County	Ohio
Population, 2000	845,303	11,353,140
Population, 1970	924,018	10,657,423
Land area (square miles), 2000	407	40,948
Persons per square mile, 2000	2,075.1	277.3
Unemployment rate, 2000	3.5%	4.1%
Poverty rate, 1999	11.8%	10.6%
Median household money income, 1999	$40,964	$40,956
Per capita money income, 1999	$24,053	$21,003
Median value of owner-occupied housing units, 2000	$111,400	$103,700
Households, 2000	346,790	4,445,773
Housing units, 2000	373,393	4,783,051
Homeownership rate, 2000	59.9%	69.1%
Persons per household, 2000	2.38	2.49

Source: U.S. Census Bureau, 2000 Census

Table 5.3.1 also presents the most recent Census Bureau data for income and poverty levels for Hamilton County and the State of Ohio. The 1999 Census revealed that the per capita income was $24,953 for Hamilton County, and $21,003 for the State of Ohio. The poverty rate was 11.8% for Hamilton County and 10.6% for the State. In addition, Table 5.3.1 provides information regarding the general housing characteristics of the project area.

The 2000 Census showed that the racial composition of the project area was predominantly white. In comparison to the State of Ohio, Hamilton County has a higher minority population. Table 5.3.2 shows the racial composition of Hamilton County compared to the State of Ohio.

TABLE 5.3.2
Population Breakdown by Race

RACE	Hamilton County		Ohio	
	Number	Percent	Number	Percent
One race	834,174	98.7	11,195,255	98.6
White	616,487	72.9	9,645,453	85.0
Black or African American	198,061	23.4	1,301,307	11.5
American Indian and Alaska Native	1,481	0.2	24,486	0.2
Asian	13,602	1.6	132,633	1.2
Native Hawaiian and Other Pacific Islander	242	0.0	2,749	0.0
Some other race	4,301	0.5	88,627	0.8
Two or more races	11,129	1.3	157,885	1.4

Source: U.S. Census Bureau, 2000 Census

Table 5.3.3 describes the composition of the labor market in Hamilton County and the State of Ohio by employment categories. Hamilton County and the State of Ohio are similar in percentage for health and social services (20.8% and 19.7% respectively), which make up a large percentage of employment. The State of Ohio has a higher percentage of employment in manufacturing than does Hamilton County, whereas Hamilton County has a higher percentage of employment for the other service-related categories. The remaining employment categories are similar for Hamilton County and the State of Ohio. Hamilton County is highly developed, as indicated by the low percentage of employment in the agricultural field.

TABLE 5.3.3
Labor Market

INDUSTRY	Hamilton County		Ohio	
	Number	Percent	Number	Percent
Agriculture, forestry, fishing and hunting, and mining	531	0.1	57,518	1.1
Construction	22,526	5.6	324,553	6.0
Manufacturing	58,732	14.5	1,082,185	20.0
Wholesale trade	15,352	3.8	193,219	3.6
Retail trade	46,163	11.4	643,058	11.9
Transportation and warehousing, and utilities	18,940	4.7	267,324	4.9
Information	11,238	2.8	128,081	2.4
Finance, insurance, real estate, and rental and leasing	31,848	7.9	339,090	6.3
Professional, scientific, management, administrative, waste services	46,407	11.5	434,694	8.0
Educational, health and social services	84,099	20.8	1,064,882	19.7
Arts, entertainment, recreation, accommodation and food services	34,716	8.6	403,684	7.5
Other services (except public administration)	18,570	4.6	242,149	4.5
Public administration	16,070	4.0	221,738	4.1

Source: U.S. Census Bureau, 2000 Census

5.4 NATURAL RESOURCES

As stated in Section 5.1, Hamilton County, Ohio, is a highly developed, urbanized area. Residential and industrial development within the City of Cincinnati dominates the area, but some pockets of woodland areas are left untouched due to severe topography. The pattern of development in Hamilton County has been influenced by major streams that flow through the area. A narrow strip of riparian habitat exists on either side of the Mill Creek where stream modifications have not been made. The extent of this habitat is severely limited by surrounding industrial, residential, and commercial development.

The U.S. Fish and Wildlife Service (USFWS) disclosed that the project area was within range of the Indiana bat (*Myotis sodalis*) and running buffalo clover *(Trifolium stoloniferum).* Both are federally listed endangered species. Live and dead trees and snags along riparian corridors, especially those with exfoliating bark or cavities for potential roost areas, are of importance to the habitat of the Indiana bat. The study area was also found to lie within the range of the federally listed threatened bald eagle (*Haliateetus leucocephalus*).

Upon examination of quadrangle maps provided by the USGS, the Ohio Department of Natural Resources (ODNR) identified other species and areas that could be of concern. The

ODNR identified the presence of the threatened passion-flower (*Passiflora incarnata)* and the Rock Elm Ohio Champion Big Tree. They also identified an Oak Maple Forest Plant Community as well as a Mixed Mesophytic Forest Plant Community. These communities are located outside the immediate study area. No other state nature preserves or scenic rivers were acknowledged to be in the area.

The study area is known to contain narrow strips of jurisdictional wetland habitat along the banks of Mill Creek. These wetland areas include sites classified as palustrine emergent, scrub/shrub, and deciduous broadleaved forested wetland areas. Small, isolated areas of other wetland types exist in the area but are located well outside the proximity of the study area.

5.5 CULTURAL RESOURCES

Segments designated for construction within the study area were identified for historical significance. Sections 2, 4B, 5, and 6 contained two historic sites. One site is a pair of bridge abutments located on both banks of Mill Creek about 1,800 feet south of Seymour Road. The other site is a historic foundation with associated artifact scatter.

Section 7A contained no cultural resources or sites. By contrast Section 7B contained one historic site and three prehistoric sites. The historic site is a limestone and cinder block foundation with nearby coal and coal piles. The three prehistoric sites were small prehistoric lithic scatters and flakes.

Section 7C enclosed two potential historic resource sites. One site is a bridge abutment and the other site is a bridge near the East Fork. These sites are thought to be related. They are badly deteriorated and likely to have limited historic resources.

5.6 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW) SITES

The main stem of the Mill Creek Valley has been used for industrial purposes for over 150 years. As a direct result of this longstanding industrial usage, the potential for encountering hazardous materials and contaminated sites along its banks is high.

An HTRW inventory of the study area was completed between 1998 and 2001. Soil borings were conducted to indicate the presence of anthropomorphic materials commonly associated with hazardous substances. In order to screen flood damage reduction alternatives, it was necessary to consider what soil might be disturbed and what soil disposal might be required for each alternative. Sites containing, or potentially containing, HTRW[2] materials were

[2] As used in US Army Corps of Engineers Regulation ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects, the term "hazardous, toxic, and radioactive waste", or "HTRW", means any material listed as a "hazardous substance" under the Comprehensive Environmental Response, Compensation and Liability Act, as amended, 42 U.S.C. §9601 et seq. (CERCLA). Hazardous substances regulated under CERCLA include "hazardous wastes" under Sec. 3001 of the Resource Conservation and Recovery Act, 42 U.S.C. 6921 et seq; "hazardous substances" identified under Section 311 of the Clean Air Act, 33 U.S.C. 1321, "toxic pollutants" designated under Section 307 of the Clean Water Act, 33 U.S.C. 1317, "hazardous air pollutants" designated under Section 112 of the Clean Air Act, 42 U.S.C. 7412; and "imminently hazardous chemical substances or mixtures" which Environment Protection Agency (EPA) has regulated under Section 7 of the Toxic Substance Control Act, 15 U.S.C. 2606.

documented. These sites were evaluated for: 1) potential to impact the cost of implementing a flood control alternative; and 2) suitability for implementation in view of the need to construct, operate and maintain an alternative in an environmentally safe manner. The evaluations were based upon Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance. Ratings – low, moderate, and high - were assigned to the sites based on the probability of contamination. Table 5.6.1 presents the results for areas adjacent to the banks of Mill Creek. For ease of presentation, the results of other parts of the study area are not listed in the table. However, the evaluations presented are typical of results found for the remainder of the study area. Due to the highly industrial nature, the majority of the study area was assigned a moderate to high risk for the presence of hazardous materials. The full report of the evaluations can be found in the Field Observation & Study Report prepared by Altech Environmental Services (1998 and 2001).

TABLE 5.6.1
Contamination Potential for Areas Adjacent to Mill Creek

Section	Site Description	Rating
2	Castellini Trucking Facility	Moderate
4B	Village of Elmwood Place Dump	High
4B	Center Hill Landfill	High
4B	North Bend Road Dump	High
4B	Vine Street Dump	High
5	No areas of concern identified	
6	Pristine Inc.- SUPERFUND SITE	High
7A*	East bank-St. 1866 to 1955, industrial use & borings	High
7A*	West bank- St. 1866 to 1905, waste disposal from industrial use	High
7A*	West bank- St. 1905 to 1922, historical agricultural use	Moderate
7A*	West bank- St. 1922 to 1943, adjacent industrial use	High
7A*	West bank- St. 1943 to 1955, low CERCLA risk	Low
7B	Both banks - Glendale-Millford Road to Sharon Creek, rail switching yard and general industrial use	Moderate
7B	Lower Sharon Creek, drainage from switching yard and general industrial use	High
7B	East bank- Sharon Creek to St. 1866, industrial use	Moderate
7B	East bank- St. 1866 to Sharon Road, nearby industries and evidence of dumping in soil borings	High
7B	West bank- Glendale-Millford Road to Sharon Creek, industrial use	Moderate
7B	West bank- Sharon Creek to St. 1845, near chemical facility (Ashland Chemical)	Moderate
7B	West bank-Ashland Chemical to St. 1864, industrial use	Moderate
7B	West bank- St. 1864 to 1870, adjacent industrial use	High
7B	West bank- St. 1870 to Sharon Road, rail line probably built with cinders.	Moderate
7C	North of Crescentville Road near right descending bank of East Fork, debris disposal area	None assigned
7C	Right descending bank of Mill Creek mainstem near the Airborne Express facility on the opposite bank, rust-colored seep	None Assigned
7C	Left descending bank of East Fork on the Trinity Industries facility site, potential industrial waste pit	None assigned

* Section 7A had a reported spill of hazardous material at the General Mills Plant as well as a reported leaking underground storage tank.

6. PROBLEMS, NEEDS, AND OPPORTUNITIES

This section describes the problems, needs, and opportunities associated with Mill Creek. They fall into three categories: flooding, ecosystem, and recreation.

6.1 FLOODING

The Mill Creek, Ohio, Flood Damage Reduction Project was originally authorized in response to repeated flooding of the Mill Creek watershed. Two types of conditions cause the flooding. First are winter or spring floods caused by the typical backwater flooding from the Ohio River basin, which centers on an axis along the Ohio River valley from southeastern Missouri to western New York. These include the floods of January 1913, January 1937, March 1945, January 1959, and March 1964. Second, severe thunderstorms cause flash floods such as those in July 1958, September 1971, May 1996, April 1998, and the most recent in July 2001.

The January 19-21, 1959, flood was caused by precipitation typical of great winter storms in the Ohio River basin when southerly winds transported a large mass of warm moist air from the Gulf of Mexico to the Ohio Valley. This system contacted a high-pressure system from the south Atlantic coast and a low-pressure system over the Great Plains, causing the axis of the storm to occur along the Ohio River from its mouth to Cincinnati. Rainfall of up to 6 inches was recorded with runoff being high due to antecedent rainfall that occurred on January 14-17, as well as the freezing weather conditions. This storm produced a peak discharge of about 5,600 cfs at the Reading, Ohio, USGS gaging station, corresponding to a 4% chance ("25-year") event. This storm caused about $3 million in damage. The 1959 storm led to the authorization of this project.

The April 16, 1998, flood was one of the most recent and typical summer floods. Rainfall depths varied throughout the upper half of the Mill Creek basin, in southern Butler County and northern Hamilton County (Sections 7A and 7C), where flood damages occurred, from about 2.0 inches at the Butler County Sewage Treatment Plant to about 4.2 inches at Sharonville, Ohio (Sections 7A and 7C). This 18-hour storm produced a peak discharge of about 2,700 cfs near the high damage area just downstream of the confluence of Mill Creek and East Fork Mill Creek (Section 7A), corresponding to between a 10% chance event ("10-year" flood event) and a 4% chance event ("25-year" flood event). In July 2001, widely scattered heavy rainfall in southwest Ohio, including the Mill Creek basin, caused flooding in the same damage area as the 1998 flood. Flooding for this site was slightly greater than in April 1998, with a frequency approaching a 4% chance (25-year). In surrounding drainage basins this rainfall approached 4 to 8 inches in about a one-hour duration. However, for the Mill Creek basin rainfall totals and intensities did not approach this level. The July 2001 flood caused millions of dollars in damages to the community of Sharonville alone.

In addition to the storms, erosion along the banks of Mill Creek has added to the debris that already clogs the creek in some places. These obstructions tend to exacerbate flooding during rainfall events.

Due to development within the floodplain, both in Hamilton County and Butler County, the amount of impervious surface is expected to increase. This will result in less storage in the floodplain and greater run-off. It is estimated that because of this development, the flood stages will increase until the year 2015. Table 6.1.1 displays the estimated number of structures that would be damaged for a range of flood events for both the existing and future conditions.

TABLE 6.1.1
Structures Flooded (Existing and Future Conditions)

Frequency Flood	Number of Structures Flooded Existing (2002)	Future (2015)
95%	0	11
50% (2-year)	3	37
20% (5-year)	36	83
10% (10-year)	235	269
4% (25-year)	387	433
2% (50-year)	556	575
1% (100-year)	622	628
0.2% (500-year)	663	668
0.1% (1000-year)	663	668

See Appendix XIII for tables showing detailed Without-Project flood damage estimates by reach for both existing (year 2002) and future conditions (year 2015 and beyond). (Please note that the detailed values in this appendix were not indexed up to year 2002 price-levels, as were the damage and benefit data in the body and other tables of this report).

6.2 ECOSYSTEM

The ecosystem of Mill Creek has degraded over time due to heavy industrialization. Trees have been removed, debris has been deposited in the stream, and banks have eroded. Stakeholders are interested in attaining Modified Warmwater Habitat (MWH) designation and Warmwater Habitat (WWH) designation for various sections of Mill Creek. MWH applies to streams with extensive and irretrievable physical habitat modifications. Because of the extensive habitat modifications the biological criteria for warmwater habitat are not attainable. The ammonia and dissolved oxygen standards are less stringent than warmwater habitat.

Mill Creek has suffered environmental damage from pollution in the form of fecal coliform, nutrients, and industrial pollutants from direct runoff, CSOs, and leaking landfills. In December 2000, the Ohio EPA prepared a Total Maximum Daily Load (TMDL) Implementation Alternative for Mill Creek. This alternative targeted levels of water quality improvements attainable within the study area. Based on stakeholder input, the Ohio EPA has agreed to a watershed-based implementation strategy to achieve TMDL objectives. There are opportunities for the project to improve water quality in the creek through implementing combined flood control/CSO reduction features. Such an approach may also reduce or eliminate the need for other CSO facilities. Opportunities also exist for the project to assist in improving water quality by incorporating environmental features in the selected alternative.

6.3 RECREATION

Canoeists use Mill Creek only rarely because of adverse conditions. Many canoeists wear hip waders and rubber gloves to protect themselves from potential and perceived harm. No fishing takes place in the creek. A limited trailway along the creek does exist in some sections. This project is an opportunity to enhance recreational opportunities by improving water quality, creating trails and greenways, creating in-stream habitat enhancements, and planting trees.

The *Mill Creek Watershed Greenway Master Plan* (Fuller, Mossbarger, Scott, and May, June 1999) outlines viable recreational goals:

? Return Mill Creek to an attractive destination for local residents and visitors by restoring riparian corridor habitat throughout the watershed, initiating reforestation, and improving flora and fauna species diversity and number.

? Develop passive recreational facilities and parks along greenway lands close to where residents live, work, and play.

? Construct a comprehensive system of walking and biking trails on publicly owned or leased properties, which would also increase efficient transportation alternatives to city residents.

? Promote improved water quality to provide for the recreational use of waterways within the watershed, including fishing, canoeing, and swimming.

? Link historic and significant natural sites throughout the watershed with the greenway system to promote tourism and the connection of Mill Creek to the Buckeye Trail, the American Discovery Trail, the Ohio River Heritage Trail, the Ohio to Erie Trail, and the Toledo-Cincinnati Trail.

? Improve water and air quality within the watershed to benefit public health and allow education projects such as outdoor classrooms for biology, zoology, and geology.

? Work with agencies to improve water quality so that Mill Creek is designated as safe for human contact.

? Promote safety and security as key elements of the new recreational greenway system.

? Develop an intermodal transportation system that includes the trails (listed in the third bulleted section above) with bus, light rail, and ferry.

7. OBJECTIVES, CONSTRAINTS AND GENERAL REQUIREMENTS

7.1 OBJECTIVES

The authorized objective for the Mill Creek Project is flood-damage reduction. The GRR process will maintain agency and public involvement in the screening process and in the final GRR development in order to meet the primary authorized objective. The GRR may also provide an opportunity to incorporate ecosystem restoration and the development of recreational facilities. For the purposes of this screening level report, all three of these Corps-mission objectives were reviewed. As discussed in Section 2, selected alternatives should meet the ER-1105-2-100 criteria that the project be complete, acceptable, effective, and efficient.

7.1.1 Flood Reduction

? The selected alternative should provide flood-damage reduction.

? The analysis should consider the entire watershed with respect to causing no net rise in the 1% chance flood elevation elsewhere in the watershed.

? The selected alternative should be integrated with a Flood Warning System (FWS) to be implemented in the upper portion of the Mill Creek watershed.

7.1.2 Ecosystem Restoration

? The selected alternative should incorporate ecosystem restoration measures that are consistent with the flood-damage reduction purpose of the project.

? The selected alternative should minimize disturbances to the remaining riparian corridor and aquatic habitat.

? The analysis should consider multiple ecosystem objectives. These could include aquatic and terrestrial ecosystem improvements and restoration.

7.1.3 Recreation

? Recreational features should be considered and incorporated into the selected alternative consistent with the financial capabilities of the sponsor and the goals of the *Mill Creek Watershed Greenway Master Plan*.

7.2 CONSTRAINTS

7.2.1 Regulatory

The approved alternative must meet the evaluation criteria of completeness, effectiveness, efficiency, and acceptability as presented in the USACE Planning Manual 96-R-21 and ER-1100-2-100.

The approved alternative should also meet the past requirements of ER 1105-2-100, including that it be economically justifiable, environmentally sustainable, publicly acceptable, and engineeringly feasible.

Additionally, the alternative must be in compliance with all local, regional, and state alternatives and policies. Alternatives should be formulated to maximize the beneficial effects and minimize the adverse impacts.

7.2.2 Socio-Economics

Socio-economic effects become constraints when careful consideration indicates a magnitude of impact that may influence project activities or progression. Considerations common to all alternatives, particularly surface alternatives, are the effects on residential, commercial, and industrial structures as well as on the infrastructure, which are subject to flooding. Damage and reconstruction costs associated with flood events have created the need for flood damage reduction. Also to be considered are the functions, operations, and activities centered on and carried out within these structures by their occupants. Given the highly industrial nature of the project area, certain activities (e.g., relocation of manufacturing facilities and/or plants and construction of flood protection structures) could prove to be costly. The functions, operations, and activities of others within the affected area, such as residential and commercial occupants, must also be evaluated. Business and residential relocations could potentially have considerable impact on area employment, community cohesion, property values, tax revenues, public facilities and services, and transportation. Land requirements and potential changes in land use are associated with each alternative and have varying potentials for realizing aesthetic and recreation benefits. Potential effects on business activity and economic growth, on public heath and safety, on surface water quality, and on the potential for controversy are additional areas for consideration[3].

[3] Environmental justice issues were not thought to be a concern for any of the alternatives that were evaluated. Further consideration will be given to environmental justice issues and the effects on minority and low income populations during later stages of the GRR.

7.2.3 Natural Resources

Wetlands: Section 2, 4B, 5, 6, 7A, 7B, and 7C of Mill Creek were found to contain areas of riverine bottoms (permanently flooded habitat located within the Mill Creek floodplain) that could qualify as wetland habitat. Portions of the creek banks in all of the sections have wooded areas potentially containing wetland habitat. An area of bottomland hardwoods was noted north of the confluence of the Mill Creek main-stem and the East Fork in Section 7C. Small pockets of other wetland habitat were noted for all sections; however, these areas lie outside of the study area limits.

Protected Species: Sections 2, 4B, 5, 6, 7A, 7B, and 7C lie within the range of the endangered Indiana bat (*Myotis sodalis*), the threatened bald eagle (*Haliateetus leucocephalus*)., and the endangered running buffalo clover *(Trifolium stoloniferum).* Although there were no specific occurrences within 0.5 miles of either bank of Mill Creek, habitat favored by the Indiana bat (roosting and foraging) and the running buffalo clover may exist within the study area.

Upon examination of quadrangle maps provided by the USGS the ODNR identified other species and areas that could be of concern. The ODNR identified two state-listed species or special habitat areas including the threatened passion-flower (*Passiflora incarnata)* and the Rock Elm Ohio Champion Big Tree. Two plant communities, the Oak Maple Forest plant Community and the Mixed Mesophytic Alternativet Community were also identified.

The plant communities of Cincinnati and the surrounding area contribute to the diversity and abundance of the vegetation that is established within the Mill Creek Valley. The dominant woodland communities contribute seed sources to the Mill Creek and represent the principal species source for the region (exclusive of cultivars and introductions). The endemic vegetation of the surrounding area over time assist in shaping the potential successional development pattern that has occurred and is likely to occur in the future within the Mill Creek Valley area. As a consequence, the Native species (including threatened and endangered flora and fauna) of the surrounding geographic and ecological areas will have an influence on natural resource development within the study area.

7.2.4 Cultural Resources

A Phase I archaeological survey was conducted using techniques such as shovel testing, walkover, and soil probing to assess the cultural resources available within the Mill Creek, Ohio, Flood Control Project site. This survey identified five historic and three prehistoric sites over the length of the project area. Many of the sites appear to have been subject to a great amount of disturbance due to development and use or were found to contain limited archaeological resources. One site containing a limestone and cinder block foundation with nearby coal and coal piles may be a possible nomination to the National Register of Historic Places (NRHP).

Investigations were done for the segments designated for construction under the Mill Creek Ohio Flood Control Project. Sections 2, 4B, 5 and 6 contained two of the five historic sites: a pair of bridge abutments located on both banks of Mill Creek about 1,800 feet south of

Seymour Road and a historic foundation with associated artifact scatter. Section 7A contained no cultural resources or sites. Section 7B contained one historic site and the previously mentioned three prehistoric sites. The historic site is a limestone and cinder block foundation with nearby coal and coal piles. The purpose of the structure could have been residential or industrial use. The three prehistoric sites were small prehistoric lithic scatters and flakes. Section 7C enclosed two potential historic resources: a bridge abutment and a bridge near East fork. These sites are thought to be related, however, they are badly deteriorated and likely to have limited historic resources.

7.2.5 Water Quality

As required under the Clean Water Act, the State of Ohio has identified Water Quality Standards to be achieved as part of the TMDL program. The final TMDL Implementation Strategy for Mill Creek is likely to include more stringent controls on both point and non-point pollution sources, as well as restoration of riverine-riparian habitat. Any alternatives recommended as part of the Mill Creek Flood Control Project should be compatible with alternatives to improve water quality in Mill Creek. The implementation of a flood control alternative must not preclude or limit the success of the TMDL Implementation Strategy.

7.2.6 Hazardous, Toxic, and Radioactive Waste

Because the watershed has experienced over 150 years of use as an industrial corridor, several sites contain or are likely to contain HTRW materials. Consistent with the guidance in ER 1165-2-132, the USACE will not participate in cleaning up material regulated by CERCLA or by the Resource Conservation and Recovery Act (RCRA). Each section of the Mill Creek Project area was investigated to determine and identify HTRW concerns (see table 5.5.1, Section 5.5). The selected alternative should avoid known HTRW sites wherever possible. The local sponsor understands that remediation for any such materials encountered would be its responsibility if the site cannot be avoided.

Two areas are marked for total avoidance due to HTRW concerns: the Center Hill Landfill and the North Bend Dump. The Center Hill Landfill is located Northwest of Mill Creek. This large facility has been closed and has been monitored by the Ohio EPA and the Cincinnati Health Department. Due to local concern and risk considerations, no disturbance of the Center Hill Landfill is planned.

North Bend Dump is located on West North Bend Road in Cincinnati, Ohio. The site is adjacent to Mill Creek and Congress Run Creek. Frederick Steel Corporation is now located in the general location of the North Bend Dump. The site is listed on the Comprehensive Environmental Response Compensation, and Liability Information System (CERCLIS) as being a potential hazardous substance site. Records indicate foundry sand, and demolition wastes were disposed of at this site. Due to local concern and risk considerations no disturbance of the North Bend site is planned.

7.2.7 Real Estate

All of the alternatives considered would require the acquisition of land, easements, and in some instances relocations or buyouts of residences or commercial/industrial sites. Costs for the purchase of real estate as well as the availability of the land present an economic and/or legal constraint for any alternative chosen.

8. METHODOLOGY

8.1 ENGINEERING

An engineering analysis was performed for each of the alternatives considered for the screening-level analysis. A brief discussion of the analysis performed is presented in Section 10. The following briefly describes the general methodology used while studying the engineering aspect of each alternative.[4]

A number of the alternatives considered would involve the demolition of residential, commercial and/or industrial facilities. The demolition procedures were examined in light of hazardous substance concerns and special handling precautions that would be needed. Cincinnati Area Geographic Information System (CAGIS) mapping was used to identify structures and parcels that would be affected. The parcel data were used with the Hamilton County Auditor files to provide building information such as size and age. Careful review of the building information identified structures that would likely contain asbestos material. Costs were determined to safely remove and dispose of the asbestos containing material. Decontamination and demolition of storage tanks was also examined as part of the study. The building information was reviewed to determine industries that reported hazardous materials storage to the Hamilton County Disaster and Emergency Services office. Costs were determined to safely remove the hazardous materials and clean the vessels containing the hazardous materials for structures that would be demolished.

The presence of lead based paint in the structures was considered in developing demolition costs. Local agencies were contacted concerning handling and disposal requirements. Hamilton County does not have local lead based paint regulations. Demolition operations in Hamilton County follow the federal regulations. These regulations would require the demolition supervisor to establish the time-weighted average (TWA) for monitoring the air concentration during demolition operations, in accordance with the lead standard. The debris created from the demolition operation may be disposed of as ordinary institutional construction debris.

Due to more than 150 years of industrial usage along the mainstem of Mill Creek, contaminated soils remain in its banks. The 1998 Altech Field Observation & Study Report analysis was reviewed to determine what level of soil contamination may be encountered during construction activities of each alternative. In addition, property listings and mapping reports of industrial sites and regulated units were purchased. Parcels where existing soil would likely be impacted by CERCLA regulated materials were plotted on scale electronic drawings. Areas where CERCLA regulated materials were indicated were verified by comparison to CAGIS mapping. These areas were then compared to the alternatives set forth in the screening process. Efforts were made to avoid known HTRW sites during the design analysis. In particular, two

[4] For this screening-level analysis, risk and uncertainty were not factored into the design of the levees and floodwalls (e.g, elevation of top of floodwall) and contingencies were used for the cost estimation. Risk and uncertainty will be incorporated during later stages of the GRR.

major HTRW sites were avoided altogether – the Center Hill landfill and the North Bend Dump; the screening-level design layouts for many of the alternatives, particular for CM and CM-2, were routed to avoid these sites.

It was assumed that any contaminated materials disturbed during construction and demolition activities would be removed, transported, and disposed off-site at an approved landfill. Contaminated material would be left as-is in areas not disturbed during construction. When designing the features of the alternatives, such as I-walls and T-walls, the quantity of potentially contaminated soil that would be disturbed was calculated. Commercial disposal facilities were contacted to determine distances that contaminated materials would need to be transported. The haul distance was assumed to be 25 miles. The quantity and distance were used when developing the cost estimates.

In order to develop designs for floodwalls and levees, foundation investigations were conducted to determine soil type and composition. The subsurface investigations which have been performed from the 1970's to the present consisted of drilling approximately 750 borings along Mill Creek. Sampling methods consisted of drive (Standard Penetration Test – SPT), rock coring, bag (hand augering or test pits – where boring locations prohibited access for a drill rig), and undisturbed sampling. Laboratory testing of samples consisted of USCS classifications, moisture contents; Atterberg Limits, soil shear strength, and rock core testing. The subsurface materials encountered in each reach along the top of the existing bank show fill (brick, ashes, cinders, wood, asphalt, coal, weathered shale, concrete, gravel, glass, plastic, etc.) ranging from as little as a few feet to 30 feet.

Where floodwalls are needed, a typical I-Wall (15-ft wall height) and two typical T-Wall (20-ft and 25-ft wall height) sections were analyzed for this study. CASE programs CWALSHT and CTWALL were used to establish rudimentary geometry for the I-wall and T-walls, respectively. CWALSHT's analysis required a 36-ft embedment for a 15-ft floodwall with a total sheet pile of 51 ft. It was estimated that the sheet pile would require 15-inch width, and an additional 8 inches of concrete extending from the face of the sheet pile on the landside. It was subsequently determined that deflection in the 15 ft walls was excessive, and therefore the design of the walls will be refined in Stage 3. CTWALL uses a line of creep method to establish seepage beneath the floodwall, which can make for an unconservative evaluation of overturning stability with slightly increased dimensions. CTWALL's analysis required a 36-ft base width, 14-ft toe and a key of at least 7.4 in depth (submerged under 8 ft of soil) for a 25-ft floodwall. Also, a 20-ft floodwall would require a 28-ft base width, 9-ft toe, and a key of at least 5 ft in depth (submerged under 6 ft of soil). The base of each scenario was sloped 3.5V:1H.

Any new levees incorporated into the alternatives were designed with a 10-ft top width and a side slope of 3H: 1V. Where new levees would be constructed, it was assumed that an inspection trench would be excavated per the following:

1) if levee is less than 3 feet in height; no inspection trench would be required;
2) if levee is 3 to 6 feet in height; the inspection trench would be as deep as the levee is tall – 8 feet wide at the bottom with 1V to 1H sideslopes;

3) if levee is greater than 6 feet in height; the inspection trench would be 6 feet deep, 8 feet wide at the bottom with 1V on 1H sideslopes;
4) if the levee height exceeds 15 feet; flatter sideslopes of 1V on 4H would be constructed.

Strictly for this screening level analysis, the top elevation of floodwalls and levees were set 3 feet higher than the 1% chance ("100-year") flood elevations along the study streams. Because of the rapid rise of Mill Creek, it was assumed that any roads and railroads that cross this line of protection would require automatic closures to prevent floodwaters from entering the protected areas. The closures would consist of rolling gate closure structures with an estimated minimum base width of 25 ft. The operation and maintenance of these closures can be problematical and on-going maintenance is critical. Pumps and other forms of interior drainage would be required to remove stormwater from behind the floodwalls and levees.

The construction of artificial riffles to improve fish habitat and the planting of trees along the banks were considered in the design of alternatives. Riffle design would be composed of 3-foot diameter boulders spaced perpendicular to the stream spaced 6 ft apart on center for a width up to 75% of the channel bottom. Five rows of these riffles would be placed at each location with each row staggered with the upstream and downstream rows. These rows would be separated 7 ft on center. Locations of these riffle structures would be staggered, alternating between 500 ft and 1,000 ft along the channel. Trees would also be planted every 200 ft on both sides of the top of creek bank in areas where riffles are constructed.

The artificial riffles and plantings (these quantities for each varied from alternative to alternative) were included in the cost estimates for each alternative (where applicable) in keeping with the goal of good environmental design. Ultimately, such features may be in addition to or may be part of an environmental mitigation package included in a final recommended plan (when the GRR effort is complete). Strictly for purposes of this Stage 1 screening level evaluation, Table 8.1.1 shows the coarse assumptions that were made regarding the potential mitigation cost for each plan, based on the multi-disciplinary team's subjective estimation of impacts for each plan:

TABLE 8.1.1
Assumed Mitigation Costs as a Percent of Construction Cost

Alternative	**Team's Subjective Assessment of Overall Environmental Impacts**	**Assumed Mitigation Cost** (as a % of Initial Construction Cost)
Total Relocation (RL)	very beneficial	0 %
Non-Structural (NS)	minor negative impacts	3 %
Non-Structural 2 (NS-2)	moderate negative impacts	8 %
Non-Structural 3 (NS-3)	minor negative impacts	3 %
Channel Modification (CM)	negative impacts	10 %
Channel Modification 2 (CM-2)	moderate negative impacts	5 %
Flood Wall & Levee (FW)	negative impacts	10 %
Deep Tunnel (TU)	beneficial	0 %
Deep Tunnel 2 (TU-2)	minor negative impacts	3 %

Note that 2 of the plans (RL and TU) were considered to have a net positive environmental impact. For these, it was assumed that zero mitigation would be required.

8.2 HYDROLOGY & HYDRAULICS

A detailed hydrologic model has been developed for the Mill Creek basin for both existing and future conditions using the USACE Hydraulic Engineering Center (HEC)-1 "Flood Hydrograph Package" computer program. This model is subdivided into a total of 29 sub-basins. Included in this model are drainage areas, lags based on times of concentration, and the Soil Conservation Service (SCS) curve numbers for each sub–basin.

Water surface elevations for all floods have been computed through the use of the computer program HEC-2, "Water Surface Profiles," and converted to HEC-RAS. Field-surveyed cross sections are obtained at all bridges and some natural sections near bridges. The field-surveyed cross sections were supplemented by CAGIS 2-foot contour mapping. Roughness coefficients, Manning's "n," are based upon field inspection of the channel and overbanks, reproduction of known highwater marks for the January 1959 and April 1998 floods, and reproduction of the rating curves at the USGS gaging stations at Reading and at Carthage.

Existing Conditions used in the Hydrology and Hydraulics analysis are based on 2002 conditions. Future conditions are estimated to occur in 2015 and to remain constant thereafter. Due to the timing of the hydrographs and the large drainage area that enters the basin downstream of where future development occurs, increases in the flow at the Barrier Dam are insignificant when comparing existing versus future conditions.

Because of the potential for development within the Mill Creek basin and the associated higher flows that would be caused by this development, it is critical to determine the very best estimate of future flows. Much of this potential development is located in Butler County. Potential future development can significantly increase the flood runoff in two ways. With this development, there will be an increase in impervious area within the Mill Creek basin with lesser rainfall infiltrating the ground, thereby causing more runoff. Butler County currently has a detention basin regulation that requires that the allowable peak rate of runoff shall not exceed a pre-developed 10% chance frequency storm. If development were allowed to occur in the floodplain, valuable floodplain storage would be reduced or lost, also causing significant increases in flow if other flood control measures are not implemented. Based upon the most reasonable projection of future conditions provided for these two counties, the hydrologic models are modified to account for this development. For instance, at the confluence of Mill Creek and East Fork Mill Creek just downstream of the county line, the 1% chance future flood flow is computed to be 5,840 cfs, an increase of 800 cfs from existing conditions.

To ensure that future flows will not increase further or perhaps be reduced, Butler County has contracted for the development of a floodplain management master alternative that identifies additional flood control measures that would be utilized to offset other development. The adoption and implementation of such an alternative would help ensure the future performance of flood control measures within Hamilton County.

It should be emphasized that for this screening-level analysis, the structural alternatives were designed to keep design flows off of buildings and roads, but not to necessarily maintain flows within banks. Consequently, available storage was utilized and included in the hydrologic models for low-lying overbank areas. Therefore, a floodplain management program should be implemented that preserves the floodwater storage capacity of these areas.

8.3 REAL ESTATE

In estimating real estate costs, the current assessed value for the structures to be acquired in fee simple is used as a base. CELRL Appraisal Branch personnel obtained sales data and estimated an appropriate factor for increasing value. Vacant land sales data were obtained to estimate a value applied to each classification of vacant land (residential, industrial, and commercial). In this screening process, no analysis has been performed for value of land or structures within the floodplain as opposed to those outside the floodplain. An administrative cost has been included for the government and for MVCD (provided by MVCD).

8.4 ENVIRONMENTAL

Screening attributes, or features of the study area, that represent possible constraints on the development of the individual flood control alternatives have been identified for evaluation. The attributes were identified based on environmental, engineering/construction, cultural, and land use characteristics that require evaluation as part of the National Environmental Policy Act (NEPA) process in the review of other environmental regulations and programs.

In order to collect, present, and evaluate the attributes, digital constraint maps were prepared that display the environmental, land use, engineering/construction, and cultural attributes for the study area. A base map was prepared using a mosaic comprising Geographical Information System (GIS) coverage available for the flood control project area, the USGS 7.5-minute topographic quadrangles, and other relevant graphical information sources. The information on the map was checked and updated using digital aerial photography and field reconnaissance. Updates include the addition or deletion of structures; water bodies; and residential, commercial, and industrial areas.

Ecological attributes have been identified based on applicable state regulations and the Federal Endangered Species Act. The following attributes were considered as environmental constraints in the screening process:

? Woodlands and forests
? Known wetland areas
? Surface waters
? Recorded threatened and endangered (T&E) species locations
? Established nature preserves, refuges, wildlife management areas, etc.

Wetland data were collected from published National Wetlands Inventory (NWI) Maps, as well as other federal, state, and local resource agencies. Information on T&E species and natural features was collected from the ODNR Division of Natural Areas and Preserves and the USFWS. Natural features have no regulatory protection but are considered to be environmentally unique.

Land use attributes have been identified as a component of this program. The following attributes were considered as land use constraints in the siting process:

- Sensitive land uses (e.g., recreational areas, airstrips, communication facilities)
- Institutional land uses (e.g., churches, schools, preschools, hospitals)
- Housing, including residential subdivisions and mobile home parks
- Dense urban developments, including industrial and commercial areas

After the study area was delineated, a land use survey of the area was conducted noting land uses. County planning authorities were contacted, and local planning documents were reviewed to ensure a proposed project would not impact any identified future land use development.

Cultural attributes have been identified based on applicable federal and state regulations. The following attributes were considered as cultural constraints in the siting process.

- Archaeological sites
- Sites on the Ohio Historical Inventory
- Sites on the NRHP
- Cemeteries

Recorded archaeological and Ohio Historical Inventory sites were collected from the State Historic Preservation Office (SHPO). Properties on the NRHP were obtained from the National Park Services electronic database.

All relevant ecological, land use, and cultural information was transferred to the base map. The information contained on the base map has been reviewed and compared during the screening of the potential flood control alternatives. The primary focus is to identify potential alternatives that, to the extent possible, avoid constraints described above or minimized impacts where they could not be avoided.

8.5 ECONOMICS

Flood damage data from the 1996-1997 economic update was utilized in screening of alternatives for Mill Creek described in this report. The June 1997 report of the economic update was not an approved official document. However, that effort was conducted in a Feasibility Study level-of-detail, the floodplain is considered fully developed, and there is no significant change in the study area. Accordingly, it was felt that the June 1997 data were sufficient for this screening of alternatives. It should be noted that completely updated Feasibility-level economics will be pursued in subsequent stages of economic analysis for the GRR.

Flood damage surveys were performed during 1996 and early 1997 within the 0.2% chance floodplain of Mill Creek from the Barrier Dam to the Butler County line. For economic analysis purposes, the study area is divided into 11 sections which coincide with the construction sections for the authorized alternative. There are nine existing levees in the study area that are located in sections 6, 7A, and 7B. These levees were privately constructed and provide various degrees of protection to approximately 60 structures in commercial and industrial areas. The levee features and the project performance for a 1% chance flood were studied and reported in 1997. The information contained in the report was utilized when determining flood damages.

The historical 0.2% chance floodplain (pre-1980) were delineated on maps to show the areas and structures subject to flooding. Physical damages within the 0.2% chance floodplain were classified by the following categories: single family and multifamily residential, commercial (including industrial), public facilities, and roads and utilities.

Information for more than 1,700 structures in the study area was gathered. The majority of structure first-floor elevations were estimated using the detailed mapping. However, the first-floor elevations of the majority of the commercial properties within section 7B were determined by land-survey methods by the CELRL. The MVCD provided estimates of first-floor elevations and structural characteristics data attributed to over 1,200 of the residential structures. The majority of the residential structure values in the study area were obtained from property valuation data. Values for remaining residential structures were estimated from County and City Data Book information, which is issued by the Bureau of the Census.

Federal Emergency Management Agency (FEMA) National Flood Insurance Administration (FIA) depth-damage functions were used to estimate expected damage to both single and multifamily residential properties for depths of flooding up to the estimated 0.2% chance flood event. Content-to-structure values (ranging from 40.2% to 44.1%) for various structure types was based on FIA damage claims data as provided in EM 1110-2-1619. Damage to non-residential properties was based on interviews with owners and/or managers of facilities in the floodplain. When damage information for properties was not available from representatives of facilities, estimates were made based on experience with similar properties.

The Flood Damage Analysis (FDA) computer program, developed by the HEC, was utilized in calculating structure damage estimates. The FDA program calculates the expected annual damage for the Without-Project alternative and each alternative With Project. The economic analysis took into account damages that would be incurred up to the 0.1% chance flood event. The flood events were based on the current hydrology & hydraulics input for both existing and future (2015) hydrology.

The FDA program incorporated a method for accounting for uncertainties (potential over/underestimating) in estimates of major economic variables, such as structure first-floor elevations, structure values, structure-to-content value ratios, and depth-damage functions. The FDA program used the length of record of the gage, 56 years on Mill Creek and 84 years on the Ohio River, in calculating the uncertainty associated with the hydrology and hydraulics input variables. When calculating uncertainty associated with the hydrology and hydraulics stage discharge functions, the FDA program used the standard deviation of the error of the stage where the error becomes constant. Uncertainties in cost estimates were accounted for by the traditional method of applying contingency factors.

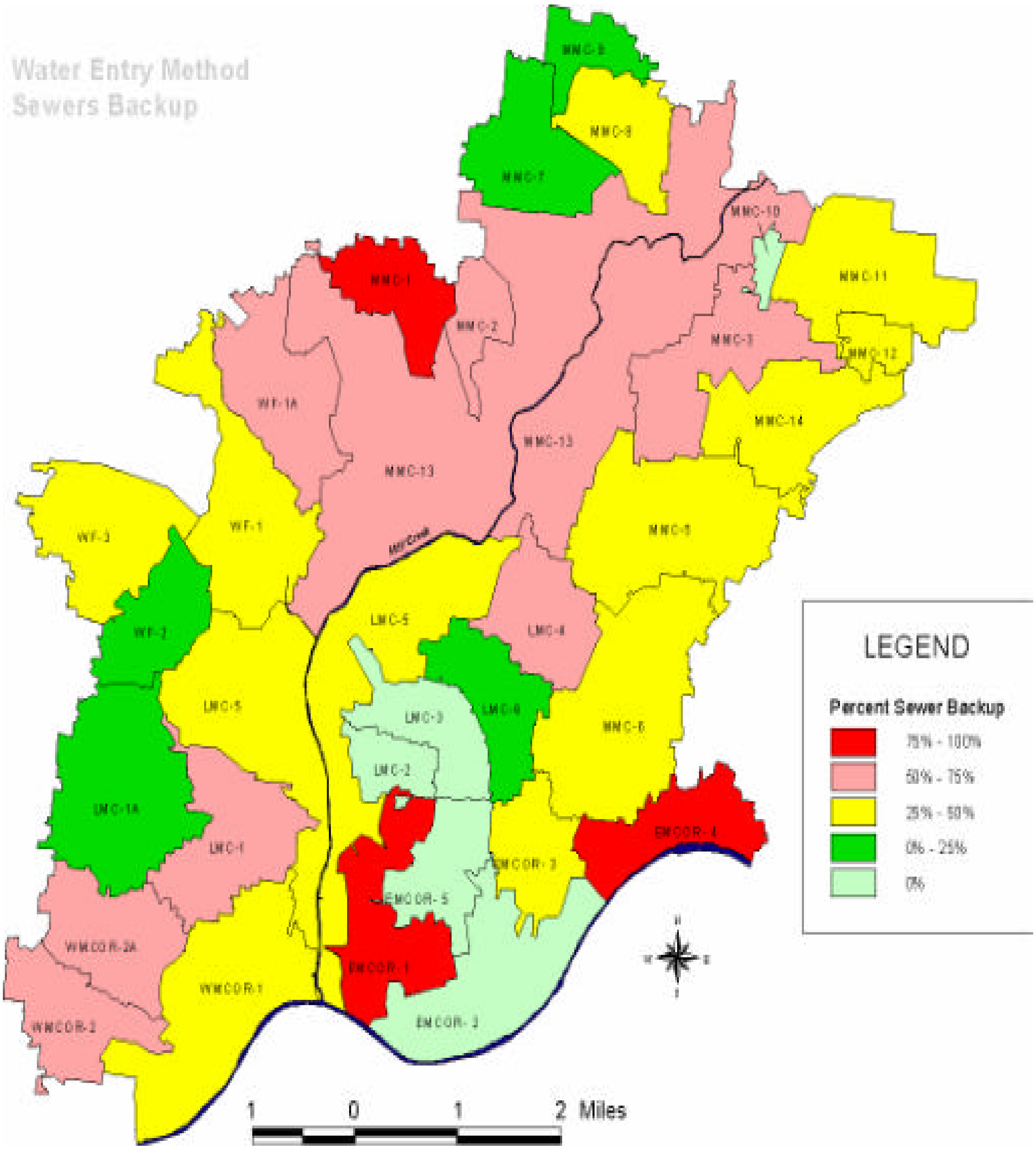
The economic analysis also takes into account the damages caused by sewer backup into basements. For the screening exercise, the overall Mill Creek Watershed was divided into roughly 30 separate sewered areas. Data drawn from the Cincinnati Area Geographic Information System (CAGIS) were used to map structure and sewer information for these areas. A comprehensive survey consisting of telephone interviews was then undertaken to establish the characteristics of flooding; including flooding experience, flooding frequency, impacts to vehicular movements, monetary damages experienced and allied topics. A total of 2,400 interviews based on random sampling were completed. The statistics generated from the sample were applied to the population of single-family homes to estimate the total value of sewer backup flooding damages. It should be noted that damages to multi-unit structures, and commercial, industrial, and public structures were not included, therefore the damages presented at the screening level are conservative.

Should alternatives which could reduce the incidence of basement sewer backup damages be selected for additional study, a more detailed analysis of these damages will be undertaken (See Figure 8.5.1, Sewer Backup Map). This will take into account such additional information as sewer discharge volumes and surcharges, flood elevations, and structure and basement elevations.

The economic benefit of a With-Project alternative is the reduction in damages when compared to the Without-Project alternative. Therefore, the average annual benefit for each alternative was calculated by taking the difference between the average annual damage for the Without-Project alternative and the average annual damage for the With-Project alternative.

The economic feasibility of an alternative was determined by comparing the benefits to the costs. If the benefit to cost ratio (BCR) was greater than 1.0, the alternative was economically justifiable. For this analysis, the average annual cost of an alternative was determined by considering a number of factors, including construction cost, length of construction period, interest during construction, and O&M costs. The costs were annualized using a discount rate of 5.875% and a project life of 50 years. The average annual cost for an alternative was subtracted from the average annual benefit to compute the net annual benefit.

FIGURE 8.5.1


Water Entry Method
Sewers Backup
LEGEND
Percent Sewer Backup
75% - 100%
50% - 75%
25% - 50%
0% - 25%
0%
1 0 1 2 Miles
MMC-1
MMC-7
MMC-11
MMC-14
MMC-13
WF-1A
WF-1
WF-3
WF-2
LMC-5
LMC-4
LMC-3
LMC-2
LMC-1A
LMC-1
EMCOR-4
EMCOR-3
EMCOR-5
EMCOR-1
EMCOR-2
WWCOR-1
WWCOR-2
WWCOR-2A

Completion of each alternative occurs in different years, ranging from 2009 to 2016. The year following construction was considered the alternative's base year. In order to account for the 50-year project life of each alternative, the Without-Project damages were adjusted to take into account the alternative base year. In order to provide an equal comparison of alternatives, a project base year of 2010 was selected. The results of alternatives estimated to be completed after 2010 were discounted using a rate of 5.875%. The economic price level used in this screening-level analysis was October 2002.

Non-physical costs often result from a flood event. These include the cost to provide emergency services and the cost of diverting traffic when streets are impassable. These cost categories were not evaluated for this screening-level analysis. Non-physical costs will be further evaluated in Stage 3.

Implementing an alternative can often cause either positive or negative impacts to the environment. Quantifying and placing a monetary value on the environmental impacts was not undertaken during this screening-level analysis. Policies and guidelines will be evaluated for inclusion in Stage 3.

9. ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD

Over the years many alternatives have been formally and informally proposed to alleviate the flooding problems along Mill Creek. These include both non-structural and structural measures. However, after studies and consideration it was found that many of these alternatives were not viable options and were subsequently dismissed — hence, they were not considered in this screening evaluation. One type of alternative which was given particular review in recent years was the use of detention ponds.

It was realized early in the prior GRR that detention basins could play an important role in the formulation of alternative. Considerable thought was given to constructing a few large detention basins in Butler County to provide protection downstream in Hamilton County. However, because of the rapid development of the floodplain in Butler County, it became apparent that these sites were no longer available for flood control storage. Consequently, other detention basin sites within Butler County and Hamilton County with lesser amounts of storage were studied. Shown below are some of the detention basin sites considered during the prior GRR evaluation in 1998-2000:

Detention Basins evaluated

a. Mill Creek in Butler County from just upstream of I-75 to just downstream of Rialto Road.

b. Mill Creek in Butler County from just downstream of Highway 747 to just downstream of Seward Road.

c. A tributary to Mill Creek in Butler County from upstream of Seward Road to downstream of Gilmore Road.

d. The Port Union Tributary to Mill Creek in Butler County upstream of Port Union Road.

e. Mill Creek in Butler County between Windisch Road and I-75.

f. East Fork Mill Creek in Butler County upstream of Allen Road to downstream of Rialto Road.

g. East Fork Mill Creek in Butler County just upstream of the community of West Chester.

h. The West Chester Tributary to East Fork Mill Creek in Butler County upstream of I-75.

i. Sharon Creek in Hamilton County downstream of Sharon Lake.

j. Existing detention basin tributary to Sharon Creek in Hamilton County. (Increase storage capacity.)

k. Cooper Creek (Evendale Tributary) located in Hamilton County upstream of Reading Road.

l. Located between Mill Creek and East Fork Mill Creek upstream of their confluence in Hamilton County.

m. Mill Creek just upstream of railroads near Sharon Creek and downstream of Medallion Drive in Hamilton County.

n. Mill Creek in Hamilton County just upstream of Formica and downstream of Glendale Milford Road.

o. Mill Creek in Hamilton County downstream of Formica and upstream of General Electric.

p. Mill Creek in Hamilton County downstream of Columbia Street at Koening Park.

Detention basin sites (a) through (j) were not feasible because either the lands were no longer available due to existing or proposed development, the detention basins did not have enough capacity to reduce the flows in the study area, or the basins were located too far upstream to have an impact in Hamilton County. (Many of these detention basins would have a significant impact on flows in Butler County but only slight reductions in flow for Hamilton County.) The remaining detention basins were later dismissed from further study based upon engineering and economic evaluation. Hence, detention basins were not included in the alternatives considered in this report's evaluations.

10.0 DESCRIPTION AND EVALUATION OF ALTERNATIVES

This section presents the alternatives that were evaluated and the results of those evaluations. The Without-Project (baseline) alternative and nine With-Project alternatives were analyzed. The With-Project alternatives considered for analysis were: total relocation (RL), non-structural (NS), non-structural 2 (NS-2), non-structural 3 (NS-3), channel modification (CM), channel modification 2 (CM-2), floodwall/levee (FW), deep tunnel (TU), and deep tunnel 2 (TU-2).

10.1 WITHOUT-PROJECT ALTERNATIVE

10.1.1 Description and Features

The Without-Project (WO) alternative is the baseline or "No Action" alternative; it provides a common base of comparison for all other alternatives. This alternative includes features and other conditions that would likely come about, even without Federal involvement or funding. The WO alternative assumes that most of Mill Creek (including both the unimproved and previously improved sections) would remain as it is today. The previous channel modifications are described in Section 5.1. No additional USACE flood control structures would be implemented. Complete maps showing the creek, buildings, and infrastructure along the creek (per the WO alternative) can be found in Appendix VI.

It is expected that over time, limited ecosystem restoration of a few floodplain areas would be undertaken (e.g., creation of small hardwood wetland areas) through programs and grants initiated by the MCRP or others. However, for purposes of this GRR, under the WO alternative, no specific ecosystem restoration would be recommended as a Federal action.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood. After implementation, the MVCD will be responsible for the O&M costs.

10.1.2 Hydrology & Hydraulics

The hydrology and hydraulics analysis has been described under Existing Conditions (Chapter 5) and the Methodology (Chapter 8). The WO alternative would not change these conditions. The water surface profiles for the existing and future conditions are shown in Appendix IV.

10.1.3 Environmental

According to the Mill Creek Greenway Master Plan (June 1999), limited riparian planting would be undertaken by the Mill Creek Restoration Project (MCRP) or others. The planned limited planting of riparian buffer areas only along the mainstem would result in some increase in stabilization of the riparian bank edges. Along with stabilization, these riparian plantings would enhance and create terrestrial habitats on top of the bank for birds, mammals, amphibians, and reptiles. Over time the terrestrial habitat improvements would result in more available forage, nesting/roosting, and concealment opportunities to endemic wildlife of the area.

In addition, the riparian plantings on the top of banks would create vegetated shaded banks that would result in a decreased thermal burden to aquatic species within the vegetated sections of the mainstem. As a part of the revegetation effect, plant biomass would be increased, providing forage materials and substrate structure suitable for macroinvertebrate species, thereby increasing the macroinvertebrate populations. This process would provide an enhanced food source for fish and other aquatic life species.

Water quality improvements would result from the reduction of CSOs entering Mill Creek. CSO issues would be addressed by the Metropolitan Sewer District's (MSD's) CSO reduction plan. CSOs at over 100 locations would be reduced through a total of approximately 85 capital improvement projects. These projects include the construction of high-rate treatment facilities, regulator improvements, pump stations, and sewer separation projects. The initial cost of this plan was estimated to be $279 million over 25 years. Refer to the *Mill Creek CSO Reduction Plan, in lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002) for design and cost analysis.

The CSO improvements would provide a significant reduction in the volume of CSOs and associated pollutant loads. The proposed CSO reduction plan provides controls for 86% of the average annual combined sewage flow. The plan would reduce the average annual volume of CSOs entering Mill Creek from 3,635 million gallons per year (MG/yr) to 730 MG/yr.

The CSO reduction plan also includes a monitoring and modeling component to ensure that water quality objectives are being met. When CSO reduction is combined with other TMDL strategies, it was anticipated that water quality in Mill Creek would improve, eventually meeting the standards for MWH designation in the lower sections and WWH designation in the upper sections of the project area.

10.1.4 Economics

10.1.4a Cost Analysis

The WO alternative assumes that most of Mill Creek (including both the unimproved and previously improved sections) would remain as it is today. The previous modifications are described in Section 5.1. Because no substantial construction work would be undertaken, there are no substantial costs associated with this alternative.

If the GRR does not recommend any of the With-Project alternatives, final GRR studies may identify some termination costs with the WO alternative—such termination costs will be addressed later in Stage 3 detailed studies. Such termination costs would likely involve features that would be included in ANY recommended plan. Hence, termination costs would likely be a "wash" economically (i.e, not affecting the Net Benefits of a recommended alternative). Hence, termination costs should not affect any of the conclusions in this document.

10.1.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the WO alternative. The economic analysis indicated that flood damage is concentrated in a few sections of the study area, with the vast majority of damage occurring in commercial and industrial structures. The commercial/industrial structures in the floodplain make up 96% of the structure damage from a 1% chance flood event; less than 1% of damage is to residential properties. Of the total damage during a 1% chance flood event, 93% occur in sections 7A and 7B; 4% in section 6; and 3% is divided among sections 7C, 2, and 5. The remaining sections have little or no damage. In addition to overbank flooding structure damage, an economic analysis was performed to determine damage to basements from sewer back-ups into residences and businesses within the sewer-shed of Mill Creek. When Mill Creek rises to certain levels, water backs up through combined sewer overflows (CSOs) and thus back-ups within the sewer system. A map showing sewer backup percentages for the study area can be found in Figure 8.5.1.

With risk and uncertainty factored in, the average annual damage for the WO alternative is estimated at $66,750,000 (project base year 2010). Table 10.1.4.1 displays the damage estimates for selected years.

TABLE 10.1.4.1
Without-Project Damage Estimates (thousands of dollars)

Year	N[5]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$29,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$49,800	$9,400	$57,400
2010	1	$51,600	$9,400	$59,200
2011	2	$53,400	$9,400	$61,000
2012	3	$55,200	$9,400	$62,800
2013	4	$57,000	$9,400	$64,600
2014	5	$58,836	$9,400	$66,400
2015	6	$58,836	$9,400	$68,236
2016	7	$58,836	$9,400	$68,236
2017	8	$58,836	$9,400	$68,236
2018	9	$58,836	$9,400	$68,236
2019	10	$58,836	$9,400	$68,236
2024	15	$58,836	$9,400	$68,236
2029	20	$58,836	$9,400	$68,236
2034	25	$58,836	$9,400	$68,236
2039	30	$58,836	$9,400	$68,236
2044	35	$58,836	$9,400	$68,236
2049	40	$58,836	$9,400	$68,236
2054	45	$58,836	$9,400	$68,236
2059	50	$58,836	$9,400	$68,236
Total		$2,914,638	$470,000	**$3,384,638**
Present Value (2010)		$919,953	$150,786	**$1,070,739**
Avg Annual Damage (2010)		$57,350	$9,400	**$66,750**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The estimated completion schedule varies for the alternatives being evaluated. The year following construction was considered the "alternative base year" for each With-Project alternative. Because the With-Project alternatives have different completion schedules, and therefore different alternative base years, the annual average damage estimate for the WO alternative was recalculated in order to account for discounting over the 50-year project life. This allowed the WO average annual damage to be compared to the average annual damage for

[5] "N" equals the number of years after the completion of construction. The base year (N=1) is the earliest year that any of the with-project alternatives would generate benefits.

each With-Project alternative when calculating the benefits. Table 10.1.4.2 displays the average damages for selected years and the average annual damage based on the alternative base year.

TABLE 10.1.4.2
WO Average Annual Damage Based on Alternative Base Year

Year	Annual Damage	Applicable Alternative				
		RL	NS, NS-2, NS-3	CM, CM-2, TU-2	FW	TU
2010	$59,200,000	1				
2011	$61,000,000	2	1			
2012	$62,800,000	3	2	1		
2013	$64,600,000	4	3	2		
2014	$66,400,000	5	4	3	1	
2015	$68,236,000	6	5	4	2	
2016	$68,236,000	7	6	5	3	
2017	$68,236,000	8	7	6	4	1
2018	$68,236,000	9	8	7	5	2
2023	$68,236,000	14	13	12	10	7
2028	$68,236,000	19	18	17	15	12
2033	$68,236,000	24	23	22	20	17
2038	$68,236,000	29	28	27	25	22
2043	$68,236,000	34	33	32	30	27
2048	$68,236,000	39	38	37	35	32
2053	$68,236,000	44	43	42	40	37
2058	$68,236,000	49	48	47	45	42
2059	$68,236,000	50	49	48	46	43
2060	$68,236,000		50	49	47	44
2061	$68,236,000			50	48	45
2062	$68,236,000				49	46
2063	$68,236,000				50	47
2064	$68,236,000					48
2065	$68,236,000					49
2066	$68,236,000					50
Average Annual Damage		**$66,750,000**	**$67,226,000**	**$67,618,000**	**$68,128,000**	**$68,236,000**
Alternative Base Year		**2010**	**2011**	**2012**	**2014**	**2017**

Notes: discount rate 5.875%; 50-year project life (represented by the number in column); price level in 2002 dollars

During the engineering analysis, the O&M requirements for each alternative were determined. The costs were calculated and included in the cost estimates. Because the O&M requirements were already considered with each alternative, the O&M requirements for the WO alternative would not need to be undertaken. Therefore, the O&M cost for the WO alternative was considered a cost avoided and was included as a benefit to each alternative described below. The average annual O&M cost for the WO alternative was estimated at $34,000. Detailed life-cycle costs for O&M can be found in Appendix V.

10.1.4c Economic Evaluation

The WO alternative is the baseline or "No Action" alternative that provides the basis of comparison for all other alternatives. This alternative includes features and other items that would likely come about, even without Federal involvement or funding. The WO alternative was assumed to have no net costs or benefits associated with it. Any change that comes about as a result of implementing a With-Project alternative, such as a reduction in flood related damages or an incremental change in O&M cost, would be considered a cost or a benefit compared to the WO.

10.2 TOTAL RELOCATION (RL)

10.2.1 Description and Features

The RL alternative considers the relocation of all businesses and residences in the existing 4% ("25-year") chance floodplain of Mill Creek. The alternative would include both the purchase of properties and compensation for moving and relocation expenses for current property owners, residents, and tenants. Maps showing buildings and pavements to be removed for the RL alternative can be found in Appendix VII.

For the RL alternative, detailed mapping showing the 4% chance floodplain along the entire length of Mill Creek was used to identify the properties to be acquired (refer to maps in Appendix VI for 4% chance floodplain). The existing residential and commercial structures (Table 10.2.1.1) would be demolished to ground (grade) level. The sites would be backfilled, compacted, graded, and seeded. Construction of the RL alternative would begin in 2007 and be completed in 2009.

TABLE 10.2.1.1
Demolition Quantities for RL Alternative

Section	Residential Structures	Commercial Structures	Roadway (yd^2)	Parking (yd^2)
8	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	114	8	32,000	25,000
5	0	0	0	0
6	188	16	34,500	46,000
7	20	67	79,800	99,900
Total	**322**	**91**	**146,300**	**170,900**

Local street pavements and local-service utilities, excluding major thoroughfares and major transmission lines, would be removed within the 4% chance floodplain. These local pavements and local utilities would no longer be needed.

The cleared property would be allowed to return to native vegetation, with limited plantings in some areas. Some areas would be graded for ponding/wetlands to occur. Limited ecosystem restoration of a few floodplain areas would be undertaken (e.g., creation of small hardwood wetland areas) in coordination with the MVCD. The previously modified sections of the Mill Creek channel would not be disturbed, except for the creation of riffles about every 500 feet to improve fish habitat and trees planted every 200 feet along both banks. In order to insure an open channel these improved sections would continue to be maintained in the future by the Millcreek Valley Conservancy District. This plan does not attempt to provide for major ecosystem restoration of the entire 25-year floodplain, but neither does it preclude such work by others in the future.

A 10-foot wide asphalt bike trail would be constructed along the channel within the right-of-way in sections 4, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.2.2 Hydrology & Hydraulics

With the acquisition and removal of the structures, some changes in overbank storage and flow patterns could occur, thereby changing the frequency of flooding. However, it was assumed these changes in storage and flow would be minimal and that use of the WO alternative hydraulics was adequate for the screening of the RL alternative. Refer to Appendix IV for the water surface profiles for the WO alternative.

10.2.3 Environmental

With the RL alternative, the removal of development from the 4% chance floodplain would allow the cleared land to be colonized by native vegetation and undergo successional development, from vacant land to old field vegetation and the scrub/shrub woody species stages until a form of BLH woodland develops with occasional field openings and gaps in the wooded canopy.

Improvements to water quality and the potential for improved aquatic species habitats would be accompanied by an increase in wildlife habitat (multiple ecotypes) that would become available for birds, mammals, amphibians, and reptile species of the area. When the 4% chance floodplain is cleared, the terrestrial habitat would provide substantial travel lanes/corridors and forage/concealment opportunities for a broad spectrum of wildlife species. Additional water quality improvements would result from the reduction of CSOs. CSOs would be addressed by MSD's CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek*, (October 2002). It should be noted that a temporary degradation of water quality during the construction phase would likely occur.

The limited ecosystem restoration at the junction of the mainstem and the East Fork Creek would consist of plantings of trees and associated species designed to undergo successional development. Soil erosion and sediments would be reduced as the result of this action. An associated environmental impact would be the improvement in surface water quality through reduction in turbidity, total dissolved solids (TDS), and total suspended solids (TSS) as the result of more extensive vegetation growth and filtering of the surface stormwaters and runoff waters entering into Mill Creek. Riparian vegetation development would improve available wildlife habitat. The planting of trees along the previously completed mainstem would promote reduction of the thermal burden in the surface water of the creek by shading, thus lowering the ambient water temperature and making the aquatic ecosystem more suitable for a wider diversity of species as well as increased individual species populations. Restored planted areas would serve as seed traps by collecting the disseminated seeds of nearby vegetation, thereby promoting regrowth, species diversity, and species competition for the overstory, understory, and shrub/ground cover strata.

In-channel improvements would be undertaken as a component of this alternative. They would include the creation of artificial riffle areas in previously modified sections that would provide flow modification and serve as physical water energy dissipaters under normal flow conditions. At the ends of the riffle areas, pooled areas of re-oxygenated water would provide a more diverse habitat for a wider range of aquatic organisms. The riffle areas and flow diverters would increase the dissolved oxygen and enhance the pool-rifle-glide configuration within the individual sections of Mill Creek, promoting increased numbers and diversity of fish and other aquatic species.

A beneficial effect of the RL alternative would be the removal of facilities from the floodplain that use, handle, or store hazardous substances, and the elimination of their potential to contaminate the creek should a leak or spill occur.

10.2.4 Economics

10.2.4a Cost Analysis

The real estate cost estimate was based on the cost to buy the land and relocate businesses and residences located within the 4% chance floodplain. In accordance with ER 405-1-12, Chapter 5, “Estates”, the Estate 1, Fee is required for all real estate acquisition. (These estate types (e.g., Estate 1-- “Fee”) refer to categories of real estate compensation, and not to specific parcels). The estimated cost for real estate acquisition is $497 million (Table 10.2.4.1).

TABLE 10.2.4.1
Real Estate Costs for RL Alternative

Component	Acres	Unit Value	Total Value
Fee Simple			
Vacant Land – Industrial	241	$85,000	$20,485,000
Vacant Land – Commercial	23.1	$225,000	$5,198,000
Vacant Land – Residential	63.1	$90,000	$5,679,000
Improved Land – Industrial	963.6		$195,764,000
Improved Land – Commercial	92.6		$13,790,000
Improved Land – Residential	252.4		$18,410,000
Minerals (None)			$0
Timber (None)			$0
Fee Improvements (None)			$0
Easements (None)			$0
Total Land, Improvements, and Damages	1635.8		$259,326,000
Contingency (35%)			$90,764,000
			$350,090,000
TOTAL ESTIMATED LAND COSTS			**$350,100,000**
Relocations (Mandatory Buyout)			$140,000,000
Administration (680 Ownerships)			
Non-Federal Admin ($5,000/ownership)			$3,400,000
TOTAL LERRD			**$493,500,000**
Federal Admin ($5,000/ownership)			$3,400,000
			$496,900,000
TOTAL ESTIMATED REAL ESTATE COST			**$497,000,000**

Notes: price level in 2002 dollars

For cost estimation purposes, the structures to be demolished were divided into categories based on their size and use, and a set of assumptions for the amount of special waste for each structure in each category was developed (e.g., amount of wall board, transite[6], asbestos-insulated pipe, etc.). All demolition material was assumed to be disposed of in local landfills. Quotes were obtained for deposing of the type and quantity of material.

The cost estimate for the RL alternative includes: construction; real estate; construction management; planning, engineering, and design (PED); and mobilization/demobilization. It was assumed that no environmental mitigation cost would be incurred for this alternative, since RL should have a net positive impact to the environment. The cost estimate is $648,265,000 (Table 10.2.4.2).

[6] *Transite* is a mixture of asbestos and cementious materials that could be manufactured into various shapes.

TABLE 10.2.4.2
Cost Estimate for RL Alternative

Feature	Cost
Section 1	$8,000
Section 2	$17,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$4,974,000
Section 5	$0
Section 6	$21,095,000
Section 7	$95,248,000
Section 8	$0
Real Estate	$497,000,000
Environmental Mitigation	$0
Construction Management	$6,972,000
PED	$11,952,000
Mobilize/Demobilize	$2,988,000
Utility Conflicts	$7,486,000
Traffic Control	$498,000
TOTAL	**$648,265,000**

Notes: price level in 2002 dollars

Completion of the RL alternative is estimated for 2009, with the alternative base year being 2010. For this analysis, the construction costs were assumed to be uniformly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and the interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2010 alternative base year is estimated at $44,279,000 (Table 10.2.4.3). See Appendix V for detailed life cycle costs.

TABLE 10.2.4.3
Average Annual Cost for RL Alternative

First Cost	Interest During Construction	Avg Annual First Cost	Avg Annual O&M	Avg Annual Cost (2010)
$648,265,000	$61,163,000	$44,226,000	$53,000	$44,279,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.2.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area, while a separate analysis was used to estimate the damage to basements from sewer back-up. Structure damage reduction would begin prior to the completion of the project because structures would be removed from the floodplain. For this reason, the benefit calculation took into account the damage reduction for the year prior to the alternative base year. With risk and uncertainty factored in, the average annual damage for the RL alternative is estimated at $13,043,000 (base year 2010). Table 10.2.4.4 displays the damage estimates for selected years.

TABLE 10.2.4.4
Average Damage Estimate for RL Alternative (thousands of dollars)

Year	N[7]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$3,049	$9,400	$12,449
2010	1	$3,163	$9,400	$12,563
2011	2	$3,277	$9,400	$12,677
2012	3	$3,392	$9,400	$12,792
2013	4	$3,506	$9,400	$12,906
2014	5	$3,620	$9,400	$13,020
2015	6	$3,737	$9,400	$13,137
2016	7	$3,737	$9,400	$13,137
2017	8	$3,737	$9,400	$13,137
2018	9	$3,737	$9,400	$13,137
2019	10	$3,737	$9,400	$13,137
2024	15	$3,737	$9,400	$13,137
2029	20	$3,737	$9,400	$13,137
2034	25	$3,737	$9,400	$13,137
2039	30	$3,737	$9,400	$13,137
2044	35	$3,737	$9,400	$13,137
2049	40	$3,737	$9,400	$13,137
2054	45	$3,737	$9,400	$13,137
2059	50	$3,737	$9,400	$13,137
Total		$185,127	$470,000	**$655,127**
Present Value (2010)		$58,598	$151,297	**$209,895**
Avg Annual Damage (2010)		$3,653	$9,432	**$13,043**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the RL alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the RL alternative, and then adding the O&M costs for the WO alternative that would be avoided. Table 10.2.4.5 displays the total annual benefits for the base year.

---

[7] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

TABLE 10.2.4.5
Benefit Calculations for RL Alternative

WO Alternative Damage (2010)	RL Alternative Damage (2010)	Avoided O&M Cost	Annual Benefit (2010)
$66,750,000	$13,043,000	$34,000	$53,741,000

Notes: price level in 2002 dollars

10.2.4c Economic Evaluation

The economic feasibility of the RL alternative was determined by comparing the benefits and the costs (Table 10.2.4.6). The RL alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

TABLE 10.2.4.6
Economic Evaluation of RL Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$53,741,000	$44,279,000	1.21	$9,462,000

Notes: price level in 2002 dollars

10.2.5 Summary

The RL alternative does completely and effectively meet the primary object of providing flood damage reduction. Protection offered by the alternative extends to the 4% chance event. Preliminary estimates indicate that the RL alternative is cost efficient. However, relocation of businesses to other areas possibly outside of the state or county and the significant loss of tax revenue would threaten community, state and local government acceptability of this alternative. The RL alternative would not disturb the channel of Mill Creek and the bank areas would be restored with riparian vegetation. As explained in Section 8.1, all excavated special waste (contaminated waste) would be disposed of in accordance with regulations and in a designated landfill.

The RL alternative does not satisfy all of the four current evaluation criteria of the USACE planning guidelines listed in Section 2.4; namely, the RL fails under the criteria of "acceptability" due to the significant loss of tax base and employment in the study area. It is also not as efficient as the NS plan described below (NS has higher net benefits).

10.3 NON-STRUCTURAL (NS)

10.3.1 Description and Features

The NS alternative is similar to the RL alternative in that it would involve relocating the majority of businesses and residences to areas outside of the 4% chance floodplain. However, the NS alternative would protect and leave in place 25 structures, which collectively account for approximately 80% of all damages in the study area. These 25 structures would be protected with eight new or improved ring-levees or floodwalls. The selected 25 structures are comprised of industrial facilities located in section 7. Maps showing areas of impact for the NS alternative can be found in Appendix VIII.

The selected structures would be protected through the construction of 11,422 lf of levees and 13,118 lf of floodwalls (Table 10.3.1.1). To assure FEMA insurance protection, new and existing ring-levees and floodwalls would be constructed/reinforced to current FEMA standards to the 1% chance flood protection. The floodwalls and levees would include automatic gate closures and interior drainage systems (storm sewers and pump stations). Construction of the NS alternative would begin in 2007 and be completed in 2010.

TABLE 10.3.1.1
Construction Quantities for NS Alternative

Section	Levee (lf)	I-wall (lf)	Road Closures	RR Closures	Bike Trails (lf)	Riffles and Trees
8	0	0	0	0	0	No
1	0	0	0	0	0	Yes
2	0	0	0	0	0	Yes
3	0	0	0	0	0	Yes
4	0	0	0	0	4,445	Yes
5	0	0	0	0	805	No
6	0	0	0	0	10,840	No
7	11,422	13,118	27	15	10,675	No
Total	**11,422**	**13,118**	**27**	**15**	**26,765**	**N/A**

Notes: Quantities are for construction on mainstem and tributaries

For the NS alternative, detailed mapping showing the 4% chance floodplain along the entire length of Mill Creek was used to identify the properties to be acquired (refer to maps in Appendix VI for 4% chance floodplain). The floodplain was based upon existing conditions for this screening-level analysis. The residential and commercial structures not protected (Table 10.3.1.2) would be demolished to ground (grade) level and basements filled. The sites would be backfilled, compacted, graded, and seeded.

TABLE 10.3.1.2
Demolition Quantities for NS Alternative

Section	Residential Structures	Commercial Structures	Roadway (sy)	Parking (sy)
8	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	114	8	32,000	25,000
5	0	0	0	0
6	188	12	34,500	46,000
7	20	49	32,400	482,400
Total	**322**	**69**	**98,900**	**553,400**

Much of the local street pavements and local-service utilities, excluding major thoroughfares and major transmission lines, would be removed within the 4% chance floodplain. These local pavements and local utilities would no longer be needed under this alternative.

The cleared property would be allowed to revert back to native vegetation, with limited plantings in some areas. If this alternative was selected for final detailed design, some areas could be graded for the creation of ponds and wetlands. It was assumed, in particular, that limited ecosystem restoration would occur along the confluence of Mill Creek and East Fork Mill Creek (e.g., creation of small hardwood wetland areas) in coordination with the MVCD. The previously constructed sections of the Mill Creek channel would not be disturbed, except for the creation of riffles about every 500 feet to improve fish habitat and the planting of trees along the banks every 200 feet on both sides. Just as with the RL plan, this plan does not attempt to provide for large-scale ecosystem restoration of the entire cleared portions of the 25-year floodplain, but neither does it preclude such work by others in the future.

A 10-foot wide asphalt bike trail would be constructed along the channel within the right-of-way in sections 4, 5, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.3.2 Hydrology & Hydraulics

The ring levees and floodwalls included in the NS plan would result in some change in overbank storage, thereby changing the extent of frequency flood flows. However, it was assumed that these changes in storage would be minimal because many of the structures to be protected already have some level of protection, and the clearing of other floodplain land would tend to offset the loss of storage. WO alternative hydraulics were considered adequate for the screening of the NS alternative. Refer to Appendix IV for the water surface profiles for the WO alternative.

10.3.3 Environmental

The NS alternative differs from the previously described RL alternative. In the NS alternative, there would be construction of levees and floodwalls, and retention of access roads to the selected 25 protected structures. Because of this construction, a smaller acreage of habitat within the 4% chance floodplain would be available for the return of the land to riparian habitat types in various successional stages.

The removal of development from the 4% chance floodplain would allow the cleared land to be colonized by native vegetation and undergo successional development, from vacant land to oldfield vegetation and scrub/shrub woody species stages, until finally a form of Bottomland Hardwood (BLH) woodland develops with occasional field openings and gaps in the wooded canopy.

Improvements to water quality and the potential for improved aquatic species habitats would be accompanied by an increase in wildlife habitat (multiple ecotypes) that would become available for birds, mammals, amphibians, and reptile species of the area. When the 4% chance floodplain is cleared, the terrestrial habitat would provide substantial travel lanes/corridors and forage/concealment opportunities for a broad spectrum of wildlife species. Additional water quality improvements would result from the reduction of CSOs. CSOs would be addressed by MSD's CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002).

Many of the study area industries use various solvents and other chemicals in their manufacturing processes. Protecting these industrial facilities from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

The limited ecosystem restoration at the junction of the mainstem and the East Fork Creek would consist of plantings of trees and associated species designed to undergo successional development. Soil erosion and sediments would be reduced as the result of this action. An associated environmental impact would be the improvement in surface water quality through reduction in turbidity, TDS, and total suspended solids (TSS) as the result of more extensive vegetation growth and filtering of the surface stormwaters and runoff waters entering into Mill Creek. Riparian vegetation development would improve available wildlife habitat. The planting of trees along the previously constructed sections of the mainstem would promote reduction of the thermal burden in the surface water of the creek by shading, thus lowering the ambient water temperature and making the aquatic ecosystem more suitable for a wider diversity of species as well as increased individual species populations. Restored planted areas would serve as seed traps by collecting the disseminated seeds of nearby vegetation, thereby promoting regrowth, species diversity, and species competition for the overstory, understory, and shrub/ground cover strata.

In-channel improvements would be undertaken as a component of this alternative. They would include the creation of artificial riffle areas in previously modified sections that would provide flow modification and serve as physical water energy dissipaters under normal flow conditions. At the ends of the riffle areas, pooled areas of re-oxygenated water would provide a more diverse habitat for a wider range of aquatic organisms. The riffle areas and flow diverters would increase the dissolved oxygen and enhance the pool-rifle-glide configuration within the individual sections of Mill Creek, promoting increased numbers and diversity of fish and other aquatic species.

10.3.4 Economics

10.3.4a Cost Analysis

The real estate cost estimate was based on the cost to buy the land and relocate businesses and residences located within the 4% chance floodplain. In accordance with ER 405-1-12, Chapter 5, “Estates”, the following estates are applicable to the NS alternative: Estate 1, Fee, and Estate 9, Flood Protection Levee Easement. The estimated cost for real estate acquisition is $296 million (Table 10.3.4.1).

TABLE 10.3.4.1
Real Estate Costs for the NS Alternative

Component	Acres	Unit Value	Total Value
Fee Simple			
Vacant Land – Industrial	241	$85,000	$20,485,000
Vacant Land – Commercial	23.1	$225,000	$5,198,000
Vacant Land – Residential	63.1	$90,000	$5,679,000
Improved Land – Industrial	636.7		$108,239,000
Improved Land – Commercial	92.6		$13,790,000
Improved Land – Residential	252.4		$18,410,000
Minerals [None]			$0
Timber [None]			$0
Fee Improvements [None]			$0
Easement			
Permanent Levee Easement 74			$5,550,000
Total Land, Improvements, and Damages	1308.9		$177,351,000
Contingency (35%)			$62,073,000
			$239,424,000
TOTAL ESTIMATED LAND COSTS			**$239,400,000**
Relocations [Mandatory Buyout]			$50,000,000
Administration [680 Ownerships]			
Non-Federal Admin [$5,000/ownership]			$3,400,000
TOTAL LERRD			**$292,800,000**
Federal Admin [$5,000/ownership]			$3,400,000
			$296,200,000
TOTAL ESTIMATED REAL ESTATE COSTS			**$296,000,000**

Notes: price level in 2002 dollars

For cost estimation purposes, the structures to be demolished were divided into categories based on their size and use, and a set of assumptions for the amount of special waste for each structure in each category was developed (e.g., amount of transit siding, asbestos-lined pipe, etc). All demolition material was assumed to be disposed of in local landfills. Quotes were obtained for disposing of the type and quantity of material.

The cost estimate for the NS alternative included construction; real estate; environmental mitigation; construction management; planning, engineering, and design (PED); and mobilization/demobilization. The NS alternative cost estimate is $573,486,000 (Table 10.3.4.2).

TABLE 10.3.4.2
Total Cost Estimate for NS Alternative

Feature	Cost
Section 1	$8,000
Section 2	$17,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$8,519,000
Section 5	$227,000
Section 6	$45,442,000
Section 7	$175,823,000
Section 8	$0
Real Estate	$296,000,000
Environmental Mitigation	$5,269,000
Construction Management	$12,295,000
PED	$21,077,000
Mobilize/Demobilize	$5,269,000
Utility Conflicts	$2,635,000
Traffic Control	$878,000
TOTAL	**$573,486,000**

Notes: price level in 2002 dollars

Completion of the NS alternative is estimated for 2010, with the alternative's economic base year being 2011. For this analysis, the construction costs were assumed to be uniformly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and the interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2011 alternative base year is estimated at $40,667,000 (Table 10.3.4.3). For comparison with all the other alternatives, this cost was adjusted to a project base year of 2010 and is estimated at $38,410,000. See Appendix V for detailed life-cycle costs.

TABLE 10.3.4.3
Average Annual Cost for NS Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2011)	Avg Annual O&M	Avg Annual Alternative Cost (2011)	Avg Annual Cost (2010)
$573,486,000	$75,889,000	$40,482,000	$185,000	$40,667,000	$38,410,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.3.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the NS alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the NS alternative was estimated at $14,424,000 (base year 2011). Table 10.3.4.4 displays the damage estimates for selected years.

TABLE 10.3.4.4
Average Damage Estimates for NS Alternative (thousands of dollars)

Year	N[8]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,800
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$48,000	$9,400	$57,400
2010		$49,800	$9,400	$59,200
2011	1	$4,483	$9,400	$13,883
2012	2	$4,639	$9,400	$14,039
2013	3	$4,796	$9,400	$14,196
2014	4	$4,952	$9,400	$14,352
2015	5	$5,112	$9,400	$14,512
2020	10	$5,112	$9,400	$14,512
2025	15	$5,112	$9,400	$14,512
2030	20	$5,112	$9,400	$14,512
2035	25	$5,112	$9,400	$14,512
2040	30	$5,112	$9,400	$14,512
2045	35	$5,112	$9,400	$14,512
2050	40	$5,112	$9,400	$14,512
2055	45	$5,112	$9,400	$14,512
2060	50	$5,112	$9,400	$14,512
Total		$254,002	$470,000	**$724,002**
Present Value (2011)		$80,822	$151,297	**$231,373**
Avg Annual Damage (2011)		$5,038	$9,432	**$14,424**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the NS alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the NS alternative, and then adding the O&M costs for the WO alternative that would be avoided. The total annual benefits were

[8] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

adjusted from a alternative base year of 2011 to a project base year of 2010. Table 10.3.4.5 displays the total annual benefits for both the alternative and project base years.

TABLE 10.3.4.5
Benefit Calculations for NS Alternative

WO Alternative Damage (2011)	NS Alternative Damage (2011)	Avoided O&M Cost	Annual Benefit (2011)	Adjusted Annual Benefit (2010)
$67,226,000	$14,424,000	$34,000	$52,836,000	$49,905,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.3.4c Economic Evaluation

The economic feasibility of the NS alternative was determined by comparing the benefits and the costs (Table 10.3.4.6). The NS alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

TABLE 10.3.4.6
Economic Evaluation of NS Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$49,905,000	$38,406,000	1.30	$11,495,000

Notes: price level in 2002 dollars

10.3.5 Summary

The NS Alternative, is considered engineeringly feasible, and does effectively and completely meet the primary objective of providing flood damage reduction. Preliminary estimates indicate that the NS alternative is cost efficient The NS alternative would not disturb the existing channel of Mill Creek. As part of the ecosystem restoration, trees would be planted at the tops of the banks every 200 feet in the completed sections (1, 2, 3 and 4A) with riffle structures added to the stream every 500 feet on both sides. Streambed improvements would be made for aquatic habitat. All excavated special waste would be disposed of in accordance with regulations in a designated landfill.

However, the NS alternative may not be acceptable to the Sponsor and to large segments of the community because of the impact on local communities due to the relocation of businesses and residences -- creating a significant cost and revenue loss to their tax base. The alternative may also be unacceptable because of its level-of-protection -- it buys out or protects property only within the 4% (25-year) chance floodplain.

The NS alternative does not satisfy all of the four current evaluation criteria of the USACE planning guidelines listed in Section 2.4; namely, the NS fails under the criteria of "acceptability," primarily due to the significant loss of tax base and employment in the study area.

10.4 NON-STRUCTURAL 2 (NS2)

10.4.1 Description and Features

The NS-2 alternative is similar to the NS alternative in that it would involve protecting the same 25 structures located in the 4% chance floodplain which account for the greatest portion of potential flood damages. These 25 structures are comprised of industrial facilities in section 7. However, the NS-2 differs from the NS alternative in that it would not consider the buy-out and/or relocation of the **other** businesses and residences located in the floodplain. Structures outside of the levees and floodwalls would not be protected and would still be subject to flooding. Maps showing areas of impact for the NS alternative can be found in Appendix VIII. These maps can be used to visualize the impacts of the NS-2 alternative.

The 25 selected structures would be protected through the construction of 11,422 lf of levees and 13,118 lf of floodwalls (Table 10.4.1.1). To assure FEMA insurance protection, new and existing ring-levees/floodwalls would be constructed/reinforced to current FEMA standards to provide protection from the 1% chance flood event. The floodwalls and levees would include automatic gate closures and interior drainage systems (storm sewers and pump stations). Construction of the NS-2 alternative would begin in 2007 and be completed in 2010.

TABLE 10.4.1.1
Construction Quantities for NS-2 Alternative

Section	Levee (lf)	I-wall (lf)	Road Closures	RR Closures	Riffles and Trees
8	0	0	0	0	No
1	0	0	0	0	Yes
2	0	0	0	0	Yes
3	0	0	0	0	Yes
4	0	0	0	0	Yes
5	0	0	0	0	No
6	0	0	0	0	No
7	11,422	13,118	27	15	No
Total	**11,422**	**13,118**	**27**	**15**	**N/A**

Notes: Quantities are for construction on mainstem and tributaries

For the NS-2 a small number of commercial structures would need to be demolished for the construction of the levees and floodwalls (Table 10.4.1.2). In addition to the structures, some pavement in parking areas would be removed.

TABLE 10.4.1.2
Demolition Quantities for NS-2 Alternative

Section	Residential Structures	Commercial Structures	Roadway (sy)	Parking (sy)
8	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	4	0	7,186
Total	**0**	**4**	**0**	**7,186**

Limited ecosystem restoration of a few floodplain areas would be undertaken (e.g., creation of small hardwood wetland areas) in coordination with the MVCD. The previously constructed sections of the Mill Creek channel would not be disturbed, except for the creation of riffles about every 500 feet to improve fish habitat and trees planted along the banks.

10.4.2 Hydrology & Hydraulics

The ring levees and floodwalls included in the NS alternative would result in some marginal loss of overbank storage, thereby changing the frequency and extent of flooding flows. However, it was assumed these changes in storage would be minimal because many of the structures to be protected already have some level of protection. WO alternative hydraulics were considered adequate for the screening of the NS-2 alternative. Refer to Appendix IV for the water surface profiles for the WO alternative.

10.4.3 Environmental

The NS-2 alternative provides limited opportunity for environmental restoration. Levee and floodwall construction around the selected structures would result in the reduction in surficial soils erosion and sediments generation. Many of the study area industries use various solvents and other chemicals in their manufacturing processes. Protecting these industrial facilities from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain. Additional water quality improvements would result from the reduction of CSOs. CSOs would be addressed by MSD's CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002).

In-channel improvements would be undertaken as a component of this alternative and would ostensibly be identical to those described for the previous NS alternative. In-channel improvements include creation of artificial riffle areas in previously modified sections that provide flow modification and serve as physical water energy dissipaters under normal flow conditions. At the ends of the riffle area, pools of re-oxygenated water would provide a more diverse habitat for a wider range of aquatic organisms than was previously possible without the improvements. The riffle areas and flow diverters would increase the dissolved oxygen and enhance the pool-riffle-glide configuration within Mill Creek, encouraging increased numbers and diversity of fish and other aquatic species. The planting of trees along the previously modified sections would promote some reduction of the thermal burden in the surface waters of the creek by shading, thus lowering the ambient water temperature and making the aquatic ecosystem more suitable for a wider diversity of species and increased individual species populations. Planted areas would serve as seed traps by collecting seeds of nearby vegetation and promoting re-growth, species diversity, and species competition for the overstory, understory, and shrub/ground cover strata.

10.4.4 Economics

10.4.4a Cost Analysis

The real estate cost estimate was based on the cost to acquire the land to construct the levees and floodwalls. In accordance with ER 405-1-12, Chapter 5, Estates, the following estates are applicable: Estate 1, Fee, and Estate 9, Flood Protection Levee Easement are required for real estate acquisition. The estimated cost for real estate acquisition is $8 million (Table 10.4.4.1).

TABLE 10.4.4.1
Real Estate Costs for the NS-2 Alternative

Component	Acres	Unit Value	Total Value
Fee Simple (None)			$0
Minerals (None)			$0
Timber (None)			$0
Fee Improvements (None)			$0
Easements:			
Permanent Levee Easements	74		$5,550,000
SUBTOTAL EASEMENTS			**$5,550,000**
Total Land, Improvements and Damages	74		$5,550,000
Contingency (35%)			$1,942,000
TOTAL ESTIMATED LAND COSTS ®			
Administration [50]			
Non-Federal Admin [$5,000/ownership]			$250,000
TOTAL LERRD			**$7,750,000**
Federal Admin [$5,000/ownership]			$250,000
TOTAL ESTIMATED REAL ESTATE COSTS			**$8,000,000**

Notes: price level in 2002 dollars

The cost estimate for the NS-2 alternative includes construction; real estate; environmental mitigation; construction management; PED; and mobilization/demobilization. The NS-2 alternative cost estimate is $155,132,000 (Table 10.4.4.2).

TABLE 10.4.4.2
Total Cost Estimate for NS-2 Alternative

Feature	Cost
Section 1	$8,000
Section 2	$17,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$0
Section 5	$0
Section 6	$0
Section 7	$118,147,000
Section 8	$0
Real Estate	$8,000,000
Environmental Mitigation	$7,233,000
Construction Management	$6,329,000
PED	$10,850,000
Mobilize/Demobilize	$2,712,000
Utility Conflicts	$1,356,000
Traffic Control	$452,000
TOTAL	**$155,132,000**

Notes: price level in 2002 dollars

Completion of the NS-2 alternative was estimated for 2010, with the alternative base year being 2011. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and the interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual first cost for the 2011 alternative base year is estimated at $11,210,000 (Table 10.4.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at $10,588,000. See Appendix V for detailed life cycle costs.

TABLE 10.4.4.3
Average Annual Cost for NS-2 Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2011)	Avg Annual O&M	Avg Annual Alternative Cost (2011)	Avg Annual Cost (2010)
$155,132,000	$21,805,000	$11,030,000	$180,000	$11,210,000	$10,588,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.4.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the NS-2 alternative is estimated at $24,486,000 (base year 2011). Table 10.4.4.4 displays the damage estimates for selected years.

TABLE 10.4.4.4
Average Damage Estimates for NS-2 Alternative (thousands of dollars)

Year	N[9]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$48,000	$9,400	$57,400
2010		$49,800	$9,400	$59,200
2011	1	$13,462	$9,400	$22,862
2012	2	$13,392	$9,400	$23,332
2013	3	$14,401	$9,400	$23,801
2014	4	$14,871	$9,400	$24,271
2015	5	$15,350	$9,400	$24,750
2020	10	$15,350	$9,400	$24,750
2025	15	$15,350	$9,400	$24,750
2030	20	$15,350	$9,400	$24,750
2035	25	$15,350	$9,400	$24,750
2040	30	$15,350	$9,400	$24,750
2045	35	$15,350	$9,400	$24,750
2050	40	$15,350	$9,400	$24,750
2055	45	$15,350	$9,400	$24,750
2060	50	$15,350	$9,400	$24,750
Total		$762,769	$470,000	**$1,232,769**
Present Value (2011)		$242,709	$151,297	**$392,788**
Avg Annual Damage (2011)		$15,130	$9,432	**$24,486**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the NS-2 alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the NS-2 alternative, and then adding the O&M costs for the WO alternative that would be avoided. For comparison, the annual

[9] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

benefits were adjusted from a alternative base year of 2011 to a project base year of 2010. Table 10.4.4.5 displays the total annual benefits for both the alternative and project base years.

TABLE 10.4.4.5
Benefit Calculations for NS-2 Alternative

WO Alternative Damage (2011)	NS-2 Alternative Damage (2011)	Avoided O&M Cost	Annual Benefit (2011)	Adjusted Annual Benefit (2010)
$67,226,000	$24,486,000	$34,000	$42,740,000	$40,400,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.4.4c Economic Evaluation

The economic feasibility of the NS-2 alternative was determined by comparing the benefits and the costs (Table 10.4.4.6). The NS-2 alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

TABLE 10.4.4.6
Economic Evaluation of NS-2 Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$40,400,000	$10,588,000	3.82	$29,812,000

Notes: price level in 2002 dollars

10.4.5 Summary

The NS-2 alternative is complete and does effectively meet the primary object of providing flood damage reduction; however, it would only offer protection to a small percentage of the structures in the floodplain. The utilization of ring levees would be engineeringly feasible. The NS-2 alternative would reduce only those damage costs associated with the 25 structures protected by the ring levees and floodwalls. The remaining structures in the floodplain would be left unprotected. Because only a few businesses would benefit, the NS-2 alternative would not be acceptable to the community. There would be limited environmental improvements associated with this alternative. Those improvements would be realized in enhanced aquatic and terrestrial habitat. Estimates indicate that the NS-2 alternative is cost efficient.

10.5 NON-STRUCTURAL 3 (NS-3)

10.5.1 Description and Features

The Non-Structural 3 (NS-3) alternative is also very similar to the NS alternative in that it would protect and leave in place 25 structures, which together sustain approximately 80% of all damages in the study area. However, instead of relocating businesses and residences within just the 4% chance floodplain, the NS-3 alternative would relocate all other non-protected businesses and residences located within the entire 1% chance floodplain (the entire "100-year" floodplain). The NS-3 alternative was developed to provide a direct comparison to the structural alternatives, which also provide flood protection to the 1% chance event[10]. Maps showing areas of impact for the NS alternative can be found in Appendix VIII. These maps should be used to estimate the impacts of the NS-3 alternative.

The selected structures would be protected through the construction of 11,422 lf of levees and 13,118 lf of floodwalls (Table 10.5.1.1). Because the levee and floodwall component is the same as that of the NS alternative, the construction cost would be the same as those of the NS alternative. To assure FEMA levee certification, new and existing ring-levees and floodwalls would be designed based on current FEMA risk criteria to the 1% chance flood protection. The floodwalls and levees would include automatic gate closures and interior drainage systems (storm sewers and pump stations). Construction of the NS-3 alternative would begin in 2007 and be completed in 2010.

Estimated quantity and cost data for the NS-3 alternative was based on comparative analysis using GIS and detailed estimate data from the NS alternative. GIS was used to estimate the number of structures located in the 4% and 1% chance floodplains, 758 and 1,218 respectively (refer to Appendix VI for detailed mapping). The number of structures located in the 1% chance floodplain represents a 60.6% increase over the number of structures located in the 4% chance floodplain. However, many of these structures were garages, storage tanks, and such, which are not considered primary structures. To account for this, the structure count from the NS alternative was used to adjust for the number of primary structures, which was 322 residential and 69 commercial. Based on these numbers it was projected that the number of primary structures located in the 1% chance floodplain are 517 residential and 111 commercial. For this analysis it was assumed that all 517 residential structures and 111 commercial structures would be demolished.

The residential and commercial structures not protected would be demolished to ground (grade) level and the basements filled. The sites would be backfilled, compacted, graded, and seeded. Much of the local street pavements and local-service utilities, excluding major thoroughfares and major transmission lines, would be removed within the 1% chance floodplain. These local pavements and local utilities would no longer be needed under this alternative.

---

[10] The NS-3 alternative was developed at the request of the CELRD following review of a draft version of this report. Because of the short time-frame, the NS-3 evaluation was performed at a lesser level of detail than the other alternatives. The methodology and results were passed through the Independent Technical Review process before inclusion into this report.

The cleared property would be allowed to revert back to native vegetation, with limited plantings in some areas. If this alternative was selected for final detailed design, some areas could be graded for ponding/wetlands to occur. It was assumed, in particular, that limited ecosystem restoration would occur along the confluence of Mill Creek and East Fork Mill Creek. (e.g., creation of small hardwood wetland areas) in coordination with the Sponsor. The previously constructed sections of the Mill Creek channel would not be disturbed, except for the creation of riffles about every 500 feet to improve fish habitat and trees planted along the banks every 200 feet on both sides. This plan does not attempt to provide for major ecosystem restoration of the entire cleared portions of the 1%-chance floodplain, but neither does it preclude such work by others in the future.

A 10-foot wide asphalt bike trail would be constructed along the channel within the right-of-way in sections 4, 5, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.5.2 Hydrology & Hydraulics

The ring levees and floodwalls included in the NS-3 alternative would result in some change in overbank storage, thereby changing the extent of frequency flood flows. However, it was assumed these changes in storage would be minimal because many of the structures to be protected already have some level of protection, and the clearing of other floodplain land would tend to offset the loss of storage. In general, all other hydraulic assumptions were considered to be the same as those of the NS alternative. Refer to Appendix IV for the water surface profiles for the WO alternative.

10.5.3 Environmental

The environmental impacts of the NS-3 alternative would be similar to the NS alternative, as described before in Section 10.3.3. However, NS-3 would allow a larger acreage of habitat to be available for the return of the land to riparian habitat types in various successional stages.

10.5.4 Economics

10.5.4a Cost Analysis

The costs for the NS-3 alternative were based on a comparative analysis with data from the NS alternative. Based on the greater amount of acreage, the real estate costs for the NS-3 alternative were estimated to be 35.3% higher than the NS alternative. For this screening-level analysis, the real estate costs for the NS-3 alternative were estimated to $400 million. Based on the increase in the number of structures to be removed, the other construction costs were estimated to be 88 % greater than the NS alternative. Overall costs for NS-3 are about 60.6 % greater than those for the NS alternative.

The estimated cost of the NS-3 alternative was estimated at $921,018,000. Table 10.5.4.1 displays a partial listing of the estimated costs.

TABLE 10.5.4.1
Total Cost Estimate for NS-3 Alternative

Feature	Cost
Construction Cost Sections 1 thru 8	$444,859,000
Real Estate	$400,000,000
Environmental Mitigation	$8,462,000
Construction Management	$19,745,000
PED	$33,849,000
Mobilize/Demobilize	$8,462,000
Utility Conflicts	$4,231,000
Traffic Control	$1,410,000
TOTAL	**$921,018,000**

Notes: price level in 2002 dollars

Completion of the NS-3 alternative was estimated for 2010, with the alternative base year being 2011. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and the interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2011 alternative base year is estimated at $64,997,000 (Table 10.5.4.2). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at $61,390,000. See Appendix V for detailed life cycle costs.

TABLE 10.5.4.2
Average Annual Cost for NS-3 Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2011)	Avg Annual O&M	Avg Annual Alternative Cost (2011)	Avg Annual Cost (2010)
$921,018,000	$118,718,000	$64,817,000	$180,000	$64,997,000	$61,390,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.5.4b Benefit Analysis

Similar to the NS-3 derived cost estimates, the NS-3 overbank flooding damage estimates were derived based on the NS alternative estimated overbank flooding damages and the RL alternative estimated overbank flooding damages. The NS-3 overbank flooding damages would be less than the NS alternative overbank flooding damages by the amount of overbank damage occurring to those structures located in between the 4% chance and 1% chance floodplains. These structures would be removed under the NS-3 alternative. The difference in overbank flood damage between the NS alternative and the RL alternative (the RL alternative would relocate all structures in the 4% chance floodplain) was used to estimate the damage associated with the protected high value/damage facilities. The value was used as the minimum overbank flood damage associated with the NS-3 alternative. As indicated on Table 10.5.4.3, the total average annual damages for the NS-3 alternative was estimated at $10,751,000 (base year 2011). The With-Project damages from direct overbank flooding would be $1,351,000, or about a 98 percent reduction from the Without-Project damages of $57,350,000 (per Table 10.1.4.1).

TABLE 10.5.4.3
Average Damage Estimates for NS-3 Alternative (thousands of dollars)

Year	N[11]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,800
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$48,000	$9,400	$57,400
2010		$49,800	$9,400	$59,200
2011	1	$1,205	$9,400	$10,605
2012	2	$1,247	$9,400	$10,647
2013	3	$1,290	$9,400	$10,690
2014	4	$1,332	$9,400	$10,732
2015	5	$1,374	$9,400	$10,774
2020	10	$1,374	$9,400	$10,774
2025	15	$1,374	$9,400	$10,774
2030	20	$1,374	$9,400	$10,774
2035	25	$1,374	$9,400	$10,774
2040	30	$1,374	$9,400	$10,774
2045	35	$1,374	$9,400	$10,774
2050	40	$1,374	$9,400	$10,774
2055	45	$1,374	$9,400	$10,774
2060	50	$1,374	$9,400	$10,774
Total		$68,301	$470,000	**$538,301**
Present Value (2011)		$21,670	$150,786	**$172,456**
Avg Annual Damage (2011)		$1,351	$9,400	**$10,751**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the NS-3 alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the NS-3 alternative, and then adding the O&M costs for the WO alternative that would be avoided. The total annual benefits were adjusted from an alternative base year of 2011 to a project base year of 2010. Table 10.5.4.4 displays the total annual benefits for both the alternative and project base years.

[11] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

TABLE 10.5.4.4
Benefit Calculations for NS-3 Alternative

WO Alternative Damage (2011)	NS-3 Alternative Damage (2011)	Avoided O&M Cost	Annual Benefit (2011)	Adjusted Annual Benefit (2010)
$67,226,000	$10,751,000	$34,000	$56,509,000	$53,374,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.5.4c Economic Evaluation

The economic feasibility of the NS-3 alternative was determined by comparing the benefits and the costs (Table 10.5.4.5). The NS-3 alternative has a BCR less than 1.0, indicating that it is not economically justifiable.

TABLE 10.5.4.5
Economic Evaluation of NS-3 Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$53,374,000	$61,390,000	0.87	(-$8,016,000)

Notes: price level in 2002 dollars

10.5.5 Summary

The NS-3 Alternative, is considered engineeringly feasible, and is complete and effective in meeting the primary objective of providing flood damage reduction. However, preliminary estimates indicate that the NS-3 alternative is not cost efficient. The NS-3 alternative may not be acceptable to the Sponsor and the local communities. This is because of the impact on local communities due to the relocation of businesses and residences creating a significant cost and revenue loss to their tax base. The NS-3 alternative would not disturb the existing channel of Mill Creek. As part of the ecosystem restoration, trees would be planted at the top of the banks every 200 ft. in the completed sections (1, 2, 3, and 4A) with riffle structures added to the stream every 500 ft. on alternate sides. Streambed improvements would be made for aquatic habitat. All excavated special waste would be disposed of in accordance with regulations and in a designated landfill.

The NS-3 alternative does not satisfy the evaluation criteria of the USACE planning guidelines as listed in Section 2.4; namely NS-3 fails under the criteria of “efficiency” since the alternative has no positive net economic benefits, and also fails “acceptability” due to the significant loss of tax base and employment in the study area.

10.6 CHANNEL MODIFICATION

10.6.1 Description and Features

The CM alternative is an update to the “Authorized Plan” as described in the 1975 GDM and subsequent Feature Design Memorandum (FDMs). The CM alternative considers making channel improvements to the unmodified portions of Mill Creek and some of its tributaries in order to provide protection to all structures within the 1% chance floodplain of Mill Creek. The previously modified portions of Mill Creek would be left as-is. The original authorized plan would be updated by including work on section 7C and tributaries to provide protection for the 1% chance flood level. Maps showing areas of impact for the CM alternative can be found in Appendix IX.

The CM alternative consists of modifying approximately 9.8 miles of Mill Creek and 0.5 miles of tributaries. The channel modifications would involve straightening and widening the creek, and lining in some areas (Table 10.6.1.1). The linings would consist of concrete paving, crib walls, retaining walls, rip-rap toes, and/or grass. Channel modifications would be needed for the following streams to remove tributary headwater flood flows from the Mill Creek floodplain: East Fork Mill Creek; Beaver Run/Champions Tributary; Kemper Road Tributary; Keebler Tributary; and Sharon Creek. In addition, 18 undersized bridges would also be replaced under this alternative. Construction on the CM alternative would begin in 2007 and be completed in 2011.

TABLE 10.6.1.1
Construction Quantities for CM Alternative

Section	I-wall (lf)	Channel Modification (lf)	Road Closures	Bike Trail (lf)	Riffles and Trees
8	0	0	0	0	Yes
1	0	0	0	0	Yes
2	5,600	0	1	5,740	Yes
3	0	0	0	0	Yes
4	0	10,575	0	5,550	Yes
5	0	7,925	0	7,885	Yes
6	0	19,605	0	20,435	Yes
7	0	23,435	0	11,955	Yes
Total	**5,600**	**61,540**	**1**	**51565**	**N/A**

Notes: Quantities are for construction on mainstem and tributaries.

Two areas were marked for total avoidance due to HTRW concerns: the Center Hill Landfill, located northwest of Mill Creek, and the North Bend Dump, located on West North Bend Road. The channel alignment would be altered to avoid these sites. Because of the realignment, a number of commercial and residential structures would need to be removed (Table 10.6.1.2). A number of undersized bridges would be demolished and/or replaced.

TABLE 10.6.1.2
Demolition Quantities for CM Alternative

Section	Residential Structures	Commercial Structures	Roadway (sy)	Bridges
8	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	116	5	32,000	6
5	0	0	0	1
6	0	0	0	8
7	0	0	0	3
Total	**116**	**5**	**32,000**	**18**

Excess suitable soils can be resold for use as backfill elsewhere. Contaminated materials disturbed during construction would be disposed of in a regulated landfill in accordance with State and Federal regulations.

Trees and/or other vegetation would be planted along the upper banks of the entire mainstem and riffles would be created every 500 feet to improve fish habitat.

Bike trails would be constructed along the channel within the right-of-ways in sections 2, 4, 5, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.6.2 Hydrology & Hydraulics

The CM alternative is a continuation of the design of the Authorized Plan. The increase in channel capacity with completion of this alternative would increase discharges at the downstream sections. It is not unusual for channel modifications to cause an increase in peak downstream discharges. The CM alternative would increase the quantity and velocity of flow in the channel, causing downstream flows to concentrate more rapidly. The reductions in flood stages also correspond with reductions in floodwater ponding in the overbank areas. Under existing conditions, the peak downstream flows are reduced as floodwater is temporarily stored in the overbanks. With the CM alternative, the flood stages would be lowered, reducing the volume of water stored in the overbanks. The removal and/or replacement of some of the 18 hydraulically undersized bridges would also increase downstream flows, reducing the volume of flow that would pond and be stored in the floodplain, thus increasing the maximum rate of flows.

It should be emphasized that for this analysis the channel modification was designed to keep the future 1% chance flow off buildings and roads and not within banks. Consequently, available storage was utilized and included in the hydrologic models for low-lying over-bank areas. Refer to Appendix IV for the water surface profiles for the CM alternative.

10.6.3 Environmental

The completion of the currently authorized channel improvements (per alternative CM) would disturb existing vegetation and fish and wildlife habitats, particular to narrow strips of riparian habitat that exists where no previous stream modifications have been made.

Trees planted along the mainstem would lower the ambient water temperature. However, practical benefits to fish and wildlife would likely be limited.

In-channel improvements would be undertaken as a component of this alternative and would be limited to boulder and cobble constructions at 500-foot intervals within the main channel to create artificial riffles to improve fish habitat. The artificial riffle areas would provide flow modification and serve as physical water energy dissipaters under normal flow conditions. The riffle areas would create re-oxygenated water to provide a more diverse habitat for a wider range of aquatic organisms.

Improvements to water quality would result from the reduction of CSOs, which would be addressed by MSD's CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002). Additional water quality improvements could result from protecting industrial facilities. Protecting industrial facilities, which often use various solvents and other chemicals in their manufacturing processes, from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

10.6.4 Economics

10.6.4a Cost Analysis

The real estate cost estimate was based on the cost to acquire the necessary land and easements to construct the CM alternative. In accordance with ER 4051-1-12, Chapter 5, "Estate", the following estates are required for real estate acquisition: Estate 1, Fee; Estate 8, Channel Improvement Easement; Estate 9, Flood Protection Levee Easement; Estate 11, Road Easement; and Estate 15, Temporary Work Area Easement. Mitigation sites have not been established; therefore, no real estate costs are included. The estimated cost for real estate acquisition is $48 million (Table 10.6.4.1).

TABLE 10.6.4.1
Real Estate Costs for CM Alternative

Component	Acres	Unit Value	Total Value
Fee Simple	54		$17,000,000
Minerals [None]			$0
Timber [None]			$0
Fee Improvements [Included in Fee]			$0
Easements			
Permanent Levee Easement	8		$320,000
Channel Improvement Easement	254		$9,728,000
Permanent Road Easement	0.4		$4,000
Temporary Work Area Easement	75		$953,000
Severance Damages [None]			$0
Total Land, Improvements, and Damages	391.4		$28,005,000
Contingency (35%)			$9,802,000
			$37,807,000
TOTAL ESTIMATED LAND COSTS			**$37,800,000**
Relocations			$7,105,000
Administration: 320 Tracts			
Non-Federal Administrative Costs [$5,000]			$1,600,000
TOTAL LERRD			**$46,505,000**
Federal Administrative Costs [$5,000]			$1,600,000
			$48,105,000
TOTAL REAL ESTATE COSTS (Rounded)			**$48,000,000**

Notes: price level in 2002 dollars

The cost estimate for the CM alternative was based on an estimate that had been prepared in 1991. The quantities were revised to account for the alignment change around the two landfills. Current cost databases have been used in MCACES, including updated labor costs for Hamilton County, Ohio.

The cost estimate for the CM alternative included construction; real estate; environmental mitigation; construction management; planning, PED; and mobilization/demobilization. The CM alternative cost estimate is $487,487,000 (Table 10.6.4.2).

TABLE 10.6.4.2
Total Cost Estimate for CM Alternative

Feature	Cost
Section 1	$8,000
Section 2	$7,498,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$115,820,000
Section 5	$34,859,000
Section 6	$107,595,000
Section 7	$67,236,000
Section 8	$12,000
Real Estate	$48,000,000
Environmental Mitigation	$31,304,000
Construction Management	$21,913,000
PED	$37,564,000
Mobilize/Demobilize	$9,391,000
Utility Conflicts	$4,695,000
Traffic Control	$1,565,000
TOTAL	**$487,487,000**

Notes: price level in 2002 dollars

Completion of the CM alternative is estimated for 2011, with the alternative base year being 2012. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2012 alternative base year is estimated at $35,952,000 (Table 10.6.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at $32,073,000. See Appendix V for detailed life cycle costs.

TABLE 10.6.4.3
Average Annual Cost for CM Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2012)	Avg. Annual O&M	Avg Annual Alternative Cost (2012)	Avg Annual Cost (2010)
$487,487,000	$87,663,000	$35,855,000	$97,000	$35,952,000	$32,073,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.6.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the CM alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the CM alternative was estimated at $12,257,000 (base year 2012). Table 10.6.4.4 displays the damage estimates for selected years.

TABLE 10.6.4.4
Average Damage Estimates for CM Alternative (thousands of dollars)

Year	N[12]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$48,000	$9,400	$57,400
2010		$49,800	$9,400	$59,200
2011		$51,600	$9,400	$61,000
2012	1	$2,621	$9,400	$12,021
2013	2	$2,709	$9,400	$12,109
2014	3	$2,798	$9,400	$12,198
2015	4	$2,888	$9,400	$12,288
2016	5	$2,888	$9,400	$12,288
2021	10	$2,888	$9,400	$12,288
2026	15	$2,888	$9,400	$12,288
2031	20	$2,888	$9,400	$12,288
2036	25	$2,888	$9,400	$12,288
2041	30	$2,888	$9,400	$12,288
2046	35	$2,888	$9,400	$12,288
2051	40	$2,888	$9,400	$12,288
2056	45	$2,888	$9,400	$12,288
2061	50	$2,888	$9,400	$12,288
Total		$143,848	$470,000	**$613,848**
Present Value (2012)		$45,834	$150,786	**$196,620**
Avg Annual Damage (2012)		$2,857	$9,400	**$12,257**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

[12] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

The total annual benefits of the CM alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the CM alternative, and then adding avoided O&M costs. The total annual benefits were adjusted from an alternative base year of 2012 to a project base year of 2010. Table 10.6.4.5 displays the total annual benefits for both the alternative and project base years.

TABLE 10.6.4.5
Benefit Calculations for CM Alternative

WO Alternative Damage (2012)	CM Alternative Damage (2012)	Avoided O&M Cost	Annual Benefit (2012)	Adjusted Annual Benefit (2010)
$67,618,000	$12,257,000	$34,000	$55,395,000	$49,418,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.6.4c Economic Evaluation

The economic feasibility of the CM alternative was determined by comparing the benefits and the costs (Table 10.6.4.6). The CM alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

TABLE 10.6.4.6
Economic Evaluation of CM Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$49,418,000	$32,073,000	1.54	$17,345,000

Notes: price level in 2002 dollars

10.6.5 Summary

The CM alternative completely and effectively meets the objective of providing flood damage reduction up to a 1% chance event. Preliminary estimates indicate that the CM alternative is cost effective. Environmentally, the completion of the channel would disturb existing vegetation and fish and wildlife habitats. Any HTRW contaminated material that is disturbed during excavation would be disposed of in a regulated landfill. Impacts to any small wetland areas would require mitigation. Because of the environmental consequences, the CM alternative does not meet current USACE design practice. For similar reasons, combined with the lack of pleasing aesthetics, this alternative would not receive acceptance from the community.

The CM alternative does not satisfy all of the USACE planning guidelines as listed in Section 2.4; primarily, CM fails under the criteria of “acceptability”.

10.7 CHANNEL MODIFICATION 2

10.7.1 Description and Features

The CM-2 alternative is similar to the CM alternative in that it would involve modifying the channel to provide protection against a 1% chance flood event. However, the CM-2 alternative would utilize current USACE philosophies of environmental sustainability by incorporating bioengineering when designing the channel. Bioengineering and a minimum amount of riprap would be utilized in the implementation of this alternative. The previously constructed portions of Mill Creek would be left as is. Maps showing areas of impact for the CM alternative can be found in Appendix IX. These maps should be used to estimate the impacts and alignment of the CM-2 alternative.

The CM-2 alternative assumes that widening of the channel would predominately be on one bank only. Riprap would be placed on the toe of the disturbed bank up a vertical height of four feet, which equates to the approximate ordinary high water (OHW) elevation. The riprap would be underlain with a filter stone to prevent the migration of soil out of the bank which would cause erosion of the excavated bank. The riprap design consisted of 18 inches of ODOT Type C stone underlain with 6 inches of ODOT Type #1 or #2 bedding. Above the top of the riprap toes on the disturbed bank, an erosion control fabric would be staked in place. A 10 ft band of live stakes (black willow, red twig dogwood and buttonbush) – four rows of stakes placed at 2.5 ft centers in a diamond configuration - would be placed on the disturbed bank beginning 1 ft above the riprap toes. The length of stakes would be 3 ft, with 6 inches protruding out of the bank. Table 10.7.1.1 presents the construction quantities for the CM-2 alternative. Construction on the CM-2 alternative would begin in 2007 and be completed in 2011.

TABLE 10.7.1.1
Construction Quantities for CM-2 Alternative

Section	I-wall (lf)	Channel Modification (lf)	Road Closures	Bike Trails (lf)	Riffles and Trees
8	0	0	0	0	Yes
1	0	0	0	0	Yes
2	5,600	0	1	5,740	Yes
3	0	0	0	0	Yes
4	0	10,575	0	4,250	Yes
5	0	7,925	0	0	Yes
6	0	19,605	0	11,200	Yes
7	0	23,435	0	9,300	Yes
Total	**5,600**	**61,540**	**1**	**30,490**	**N/A**

Notes: Quantities are for construction on mainstem and tributaries.

A few areas would require floodwalls to provide the desired protection. Channel modifications would also be needed for the following streams to remove tributary headwater flood flows from the Mill Creek floodplain: East Fork Mill Creek; Beaver Run/Champions Tributary; Kemper Road Tributary; Keebler Tributary; and Sharon Creek.

Two areas were marked for total avoidance due to HTWR concerns: the Center Hill Landfill, located northwest of Mill Creek, and the North Bend Dump, located on West North Bend Road. The channel alignment would be altered to avoid these sites. Because of the realignment and the widening of the channel, a number of commercial and residential structures would need to be removed (Table 10.7.1.2). In addition, a number of undersized bridges would be demolished and/or replaced.

TABLE 10.7.1.2
Demolition Quantities for CM-2 Alternative

Section	Residential Structures	Commercial Structures	Roadway (sy)	Parking (sy)	Bridges
8	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	140	6	20,827	0	2
5	0	0	0	3,869	2
6	109	0	0	0	10
7	140	6	32,006	0	11
Total	**389**	**12**	**52,833**	**3,869**	**25**

Excess suitable soils could be resold for use as backfill elsewhere. Contaminated materials would be disposed of in a regulated landfill in accordance with State and Federal regulations.

Trees and/or other vegetation would be planted along the upper banks of the entire mainstem and riffles would be created every 500 feet to improve fish habitat.

Bike trails would be constructed along the channel within the right-of-ways in sections 2, 4, 5, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.7.2 Hydrology & Hydraulics

For screening-level purposes, the CM-2 alternative was assumed to provide the same channel capacity as the CM alternative, resulting in the same 1% chance level of protection. Cross-sections were analyzed to determine the channel width that would be required to provide protection from the 1% chance flood event.

The CM-2 alternative would have higher roughness coefficients with the proposed channel raised above the existing channel bottom. The authorized CM alternative included excavation of the channel to provide more flow capacity. For these reasons, the CM-2 alternative required a much wider channel than the CM. The width of the channel was sized so that the 1% chance flood elevation for this alternative would be equal to that of alternative CM.

10.7.3 Environmental

CM-2 would disturb existing vegetation and fish and wildlife habitats, particular to narrow strips of riparian habitat that exist where no previous stream modifications have been made. However, the bio-engineered channel would not preclude future opportunities to implement some type of stream and riparian restoration. Alternative CM-2 would include advanced environmental design techniques -- including side-slope bioengineering and environmentally sustainable design elements.

Trees planted along the mainstem would promote reduction of the thermal burden in the surface water of the creek by shading, thus lowering the ambient water temperature. However, practical benefits to fish and wildlife would likely be limited.

In-channel improvements would be undertaken as a component of this alternative and would be limited to boulder and cobble constructions at 500-foot intervals within the main channel to create artificial riffles to improve fish habitat. The artificial riffle areas would provide flow modification and serve as physical water energy dissipaters under normal flow conditions. The riffle areas would create re-oxygenated water to provide a more diverse habitat for a wider range of aquatic organisms.

Improvements to water quality would result from the reduction of CSOs, which would be addressed by MSD's CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002). Additional water quality improvements could also result from protecting industrial facilities. Protecting industrial facilities, which often use various solvents and other chemicals in their manufacturing processes, from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

10.7.4 Economics

10.7.4a Cost Analysis

The real estate cost estimate was based on the cost to acquire the necessary land and easements to construct the CM-2 alternative. In accordance with ER 405-1-12, Chapter 5, Estates, the following estates are applicable: Estate 1, Fee, and Estate 9, Flood Protection Levee Easement are required for real estate acquisition. The estimated cost for real estate acquisition is $49 million (Table 10.7.4.1).

TABLE 10.7.4.1
Real Estate Costs for CM-2 Alternative

Component	Acres	Unit Value	Total Value
Fee Simple	56		$18,600,000
Minerals (None)			$0
Timber (None)			$0
Fee Improvements (Included in Fee)			$0
Easements			
Permanent Levee Easement	8		$320,000
Channel Improvement Easement	216		$8,000,000
Permanent Road Easement	0.4		$5,000
Temporary Work Area Easement	76		$966,000
Severance Damages (None)			$0
Total Land, Improvements, and Damages	**356.4**		**$27,891,000**
Contingency (35%)			$9,762,000
			$37,652,000
TOTAL ESTIMATED LAND COSTS ®			**$37,700,000**
Relocations			$8,000,000
Administration: 340 Tracts			
Non-Federal Administrative Costs ($5,000)			$1,700,000
TOTAL LERRD			**$47,400,000**
Federal Administrative Costs ($5,000)			$1,700,000
			$49,100,000
TOTAL REAL ESTATE COSTS (Rounded)			**$49,000,000**

Notes: price level in 2002 dollars

The cost estimate developed for the CM-2 alternative included construction; real estate; environmental mitigation; construction management; PED; and mobilization/demobilization. The CM-2 alternative cost estimate was $683,399,000 (Table 10.7.4.2).

TABLE 10.7.4.2
Total Cost Estimate for CM-2 Alternative

Feature	Cost
Section 1	$8,000
Section 2	$7,498,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$136,066,000
Section 5	$37,446,000
Section 6	$103,683,000
Section 7	$234,819,000
Section 8	$12,000
Real Estate	$49,000,000
Environmental Mitigation	$19,800,000
Construction Management	$27,720,000
PED	$47,520,000
Mobilize/Demobilize	$11,880,000
Utility Conflicts	$5,940,000
Traffic Control	$1,980,000
TOTAL	**$683,399,000**

Notes: price level in 2002 dollars

Completion of the CM-2 alternative is estimated for 2011, with the alternative base year being 2012. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2012 alternative base year is estimated at $50,289,000 (Table 10.7.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at $44,863,000. See Appendix V for detailed life cycle costs.

TABLE 10.7.4.3
Average Annual Cost for CM-2 Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2012)	Avg Annual O&M	Avg Annual Alternative Cost (2012)	Avg Annual Cost (2010)
$683,399,000	$121,368,000	$50,170,000	$119,000	$50,289,000	$44,863,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.7.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the CM-2 alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the CM-2 alternative was estimated at $12,257,000 (base year 2012). Table 10.7.4.4 displays the damage estimates for selected years.

TABLE 10.7.4.4
Average Damage Estimates for CM-2 Alternative (thousands of dollars)

Year	N[13]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$48,000	$9,400	$57,400
2010		$49,800	$9,400	$59,200
2011		$51,600	$9,400	$61,100
2012	1	$2,621	$9,400	$12,109
2013	2	$2,709	$9,400	$12,109
2014	3	$2,798	$9,400	$12,198
2015	4	$2,888	$9,400	$12,288
2016	5	$2,888	$9,400	$12,288
2021	10	$2,888	$9,400	$12,288
2026	15	$2,888	$9,400	$12,288
2031	20	$2,888	$9,400	$12,288
2036	25	$2,888	$9,400	$12,288
2041	30	$2,888	$9,400	$12,288
2046	35	$2,888	$9,400	$12,288
2051	40	$2,888	$9,400	$12,288
2056	45	$2,888	$9,400	$12,288
2061	50	$2,888	$9,400	$12,288
Total		$931,876	$470,000	**$613,848**
Present Value (2012)		$45,834	$150,786	**$196,620**
Avg Annual Damage (2012)		$2,857	$9,400	**$12,257**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the CM-2 alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the CM-2 alternative, and then adding avoided O&M costs. The total annual benefits were adjusted from an alternative base year of 2012 to a project base year of 2010. Table 10.7.4.5 displays the total annual benefits for both the alternative and project base years.

[13] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

TABLE 10.7.4.5
Benefit Calculations for CM-2 Alternative

WO Alternative Damage (2012)	CM-2 Alternative Damage (2012)	Avoided O&M Cost	Annual Benefit (2012)	Adjusted Annual Benefit (2010)
$67,618,000	$12,257,000	$34,000	$55,395,000	$49,418,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.7.4c Economic Evaluation

The economic feasibility of the CM-2 alternative was determined by comparing the benefits and the costs (Table 10.7.4.6). The CM-2 alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

TABLE 10.7.4.6
Economic Evaluation of CM-2 Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$49,418,000	$44,863,000	1.10	$4,555,000

Notes: price level in 2002 dollars

10.7.5 Summary

The CM-2 alternative completely and effectively meets the objective of providing flood damage reduction, but the channel work would disturb some existing vegetation and fish and wildlife habitats. Hazardous material (special waste) disturbed during construction or excavation of this alternative would be disposed of in a designated landfill and in accordance with applicable regulations. Depending on the final design and alignment, community response to this alternative could range from moderate to unacceptable. Estimates indicate that the CM-2 alternative would be cost effective.

The CM-2 alternative does satisfy the four evaluation criteria of the USACE planning guidelines listed in Section 2.4. However, because of the high initial cost, the plan has relatively low net benefits compared to the other alternatives with positive net benefits.

10.8 FLOODWALL/LEVEES

10.8.1 Description and Features

The FW alternative includes the design and construction of floodwalls and levees along Mill Creek to provide a 1% chance level of flood protection. In addition to floodwalls and levees, a few channel improvements would also be required. The construction would take place in sections 2, 4B, 6, and 7. Maps showing areas of impact for the FW alternative can be found in Appendix X.

The FW alternative consists of constructing 17,434 lf of levee, 80,861 lf of floodwall, and 13,940 lf of modifications to the channel. The proposed floodwall and levees approach 20 feet in height in many locations, and would exceed 20 feet in some areas. The channel modifications would consist of excavating the channel to the appropriate size and constructing a riprap toe lining. Many railroads, highways, county and city roads, and private drives cross this line of protection which would require closures to prevent floodwaters from entering the protected areas. Because of the rapid rise of the floodwaters in Mill Creek, automated gate closures would be used at all locations. Pump stations would be installed behind the floodwalls and levees to handle interior drainage. Floodwalls, levees, and channel modifications would be required along a number of tributaries that enter Mill Creek to prevent flooding and reduce upstream induced stage/damages. The tributaries include East Fork Mill Creek, Beaver Run/Champions Tributary, Kemper Road Tributary, Keebler Tributary, and Sharon Creek. Table 10.8.1.1 presents the construction quantities for the mainstem and tributaries of Mill Creek. Construction on the FW alternative would begin in 2007 and be completed in 2013.

TABLE 10.8.1.1
Construction Quantities for FW Alternative

Section	Levee (lf)	I-wall (lf)	T-wall (lf)	Channel Modification (lf)	Bike Trail (lf)	Road Closures	RR Closures	Riffles and Trees
8	0	0	0	0	0	0	0	No
1	0	0	0	0	0	0	0	Yes
2	0	6,002	0	0	6,587	2	0	Yes
3	0	0	0	0	0	0	0	Yes
4	1,350	6,899	775	0	7,050	4	0	Yes
5	0	0	0	0	0	0	0	No
6	7,587	19,932	655	0	16,762	19	0	No
7	8,497	37,908	8,690	13,940	12,475	22	19	No
Total	**17,434**	**70,741**	**10,120**	**13,940**	**42,874**	**47**	**19**	**N/A**

Notes: Quantities are for construction on mainstem and tributaries

Bike trails would be constructed along the channel within the right-of-ways in sections 2, 4B, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

A small number of residential structures would need to be removed for the construction of the floodwalls and levees (Table 10.8.1.2).

TABLE 10.8.1.2
Demolition Quantities for FW Alternative

Section	Residential Structures	Commercial Structures	Roadway (sy)	Parking (sy)
8	0	0	0	0
1	0	0	0	0
2	1	0	0	0
3	0	0	0	0
4	1	0	0	0
5	0	0	0	0
6	8	0	0	0
7	1	0	0	0
Total	**11**	**0**	**0**	**0**

The previously constructed sections of the Mill Creek channel would be left as is, except for the creation of riffles about every 500 feet to improve fish habitat and trees planted along the banks.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.8.2 Hydrology & Hydraulics

The screening-level design for the FW alternative assumes that the top of protection is 3 feet above the calculated 1% chance event water surface. In some locations the walls would constrict flows, inducing upstream flooding. Modifications would be required to the Beaver Run/Champions Tributary, Kemper Road Tributary, Keebler Tributary, and Sharon Creek. Levees and floodwalls also trap runoff on the interior side of the line of protection. It was assumed that the interior storage or pumping capacity would be equivalent to the existing storm sewer capacity. If detailed floodwall/levee alternatives are developed, the capacity and design of each interior system would be formulated using the computer program "Interior Flood Hazard." Refer to Appendix IV for the water surface profiles for the FW alternative.

10.8.3 Environmental

The FW alternative would restrict ecosystem restoration to locations along the mainstem where right-of-way would be available. Trees would be planted along the previously channelized sections (1, 2, 3, and 4A) of the mainstem to promote riparian tree canopy development and lowering the ambient water temperature. However, practical benefits to fish and wildlife would likely be limited.

In-channel improvements would be limited to boulder and cobble constructions at 500-foot intervals within the main channel in previously modified sections to create artificial riffles to improve fish habitat. These artificial riffle areas would provide flow modification and serve as physical water energy dissipaters under normal flow conditions.

Water quality improvements would result from the reduction of CSOs entering Mill Creek. CSO issues would be addressed by the MSD CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002). Additional water quality improvements could result from protecting industrial facilities that use solvents and other chemicals in their manufacturing process. Protecting these industrial facilities from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

10.8.4 Economics

10.8.4a Cost Analysis

In accordance with ER 405-1-12, Chapter 5, Estates, the following estates are required for real estate acquisition: Estate 9, Flood Protection Levee Easement (also Floodwalls); Estate 11, Road Easement; and Estate 15, Temporary Work Area Easement. The estimated cost for real estate acquisition is $26 million.

TABLE 10.8.4.1
Real Estate Costs for FW Alternative

Component	Acres	Unit Value	Total Value
Fee Simple (None)			$0
Minerals (None)			$0
Timber (None)			$0
Fee Improvements (None)			$0
Easements			
Permanent Levee Easement	170		$14,891,000
Permanent Road Easement	2		$43,000
Temporary Work Area Easement	30		$773,000
Severance Damages (None)			$0
Total Land, Improvements, and Damages	202		$15,707,000
Contingency Plus Rounding			$5,498,000
TOTAL ESTIMATED LAND COSTS			**$21,205,000**
Relocations (Facilities – Street Closure)*			$0
(Business – 6)			$500,000
Administration: 450 Tracts			
Non-Federal Administrative Costs ($5,000)			$2,250,000
TOTAL LERRD			**$23,955,000**
Federal Administrative Costs ($5,000)			$2,250,000
			$26,205,000
TOTAL REAL ESTATE COSTS (Rounded)			**$26,000,000**

Notes: price level in 2002 dollars
*All Costs Included in Engineering Cost Estimate

For the purpose of cost estimates, the elevation of the levees and floodwalls was set 3 feet higher than the 1% chance flood elevation. The height of the walls would be refined at a later stage of the GRR when risk and uncertainty are factored in.

The cost estimate for the FW alternative includes construction; real estate; environmental mitigation; construction management; planning, PED; and mobilization/demobilization. The FW plan cost estimate is $607,701,000 (Table 10.8.4.2).

TABLE 10.8.4.2
Total Cost Estimate for FW Alternative

Feature	Cost
Section 1	$8,000
Section 2	$21,659,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$27,972,000
Section 5	$497,000
Section 6	$93,536,000
Section 7	$298,691,000
Section 8	$0
Real Estate	$26,000,000
Environmental Mitigation	$49,188,000
Construction Management	$25,936,000
PED	$45,661,000
Mobilize/Demobilize	$11,115,000
Utility Conflicts	$5,558,000
Traffic Control	$1,853,000
TOTAL	**$607,701,000**

Notes: price level in 2002 dollars

Completion of the FW alternative is estimated for 2013, with the alternative base year being 2014. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2014 alternative base year is estimated at $47,985,000 (Table 10.8.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at $38,189,000. See Appendix V for detailed life cycle costs.

TABLE 10.8.4.3
Average Annual Cost for FW Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2014)	Avg Annual O&M	Avg Annual Alternative Cost (2014)	Avg Annual Cost (2010)
$607,701,000	$157,430,000	$47,698,000	$287,000	$47,985,000	$38,189,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.8.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the FW alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the

FW alternative was estimated at $12,282,000 (base year 2014). Table 10.8.4.4 displays the damage estimates for selected years.

TABLE 10.8.4.4
Average Damage Estimates for FW Alternative (thousands of dollars)

Year	N[14]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$48,000	$9,400	$55,600
2009		$49,800	$9,400	$57,400
2010		$51,600	$9,400	$59,200
2011		$53,400	$9,400	$61,000
2012		$55,200	$9,400	$62,800
2013		$2,798	$9,400	$64,600
2014	1	$2,888	$9,400	$12,198
2015	2	$2,888	$9,400	$12,288
2016	3	$2,888	$9,400	$12,288
2017	4	$2,888	$9,400	$12,288
2018	5	$2,888	$9,400	$12,288
2023	10	$2,888	$9,400	$12,288
2028	15	$2,888	$9,400	$12,288
2029	16	$2,888	$9,400	$12,288
2030	17	$2,888	$9,400	$12,288
2031	18	$2,888	$9,400	$12,288
2032	19	$2,888	$9,400	$12,288
2033	20	$2,888	$9,400	$12,288
2038	25	$2,888	$9,400	$12,288
2043	30	$2,888	$9,400	$12,288
2048	35	$2,888	$9,400	$12,288
2053	40	$2,888	$9,400	$12,288
2058	45	$2,888	$9,400	$12,288
2063	50	$2,888	$9,400	$12,288
Total		$144,294	$470,000	**$614,294**
Present Value (2014)		$46,236	$150,786	**$197,022**
Avg Annual Damage (2014)		$2,882	$9,400	**$12,282**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the FW alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the FW alternative, and then adding

[14] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

avoided O&M costs. For comparison, the total annual benefits were adjusted from a alternative base year of 2014 to a project base year of 2010. Table 10.8.4.5 displays the total annual benefits for both the alternative and project base years.

TABLE 10.8.4.5
Benefit Calculations for FW Alternative

WO Alternative Damage (2014)	FW Alternative Damage (2014)	Avoided O&M Cost	Annual Benefit (2014)	Adjusted Annual Benefit (2010)
$68,128,000	$12,282,000	$34,000	$55,880,000	$44,472,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.8.4c Economic Evaluation

The economic feasibility of the FW alternative was determined by comparing the benefits and the costs. The FW alternative has a BCR greater than 1.0 (Table 10.8.4.6), indicating that it would be economically justifiable.

TABLE 10.8.4.6
Economic Evaluation of FW Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$44,472,000	$38,189,000	1.16	$6,283,000

Notes: price level in 2002 dollars

10.8.5 Summary

The FW alternative effectively and completely meets the objective of providing flood damage reduction to the Mill Creek area. This alternative would have adverse aesthetic impacts, work in the channel would be required, and the construction of floodwalls and levees may preclude future opportunities for ecosystem restoration or recreation along parts of the Mill Creek.. HTRW sites would need to be addressed. Estimates indicate that the FW alternative is cost effective. The construction of floodwall and levees would be engineeringly feasible. However, problems with use of automated floodgates may create implementation difficulties.

The FW fails two of the evaluation criteria, namely effectiveness and acceptability. The plan is ineffective in that it involves 47 street closures and 19 railroad closures. This is an extremely high number of closures for floodwall/levee system, particularly along a creek where flood waters rise very quickly – the plan is operationally infeasible. If only 1 or a few of the closures failed to close at the right time in a flood emergency, little or no protection to the community would be afforded. Furthermore, many in the community would consider a floodwall / levee project to be unacceptable from an aesthetic standpoint, and the FW alternative may be incompatible with the goals of various groups in the community who are seeking improvement of the riparian corridor for the objectives of ecosystem restoration and recreation.

10.9 DEEP TUNNEL

10.9.1 Description and Features

TU alternative would involve the construction of a deep tunnel to handle a portion of the flood flows along Mill Creek. For this screening level analysis, the design and alignment of the tunnel would be identical to the plan developed in the MSD-sponsored Parsons-Brinckerhoff report of March 2002, entitled *Flood Control and CSO Tunnel*. The tunnel would begin at the confluence of Mill Creek and East Fork Mill Creek (near the Butler County line) and continue downstream over 17 miles to the Barrier dam and would provide protection up to the 1% chance flood event. A significant benefit of the TU alternative would be its ability to handle a portion of the CSOs that contribute to water degradation in Mill Creek. The tunnel would have the ability to store CSO contaminated water up to a 50% chance storm event while awaiting treatment. Maps showing the approximate alignment of the TU alternative and the locations of the drop inlets can be found in Appendix XI.

The TU alternative involves the construction of approximately 16 miles of 31-foot diameter tunnel. The tunnel would be bored through a hard limestone layer (“Lexington Limestone”) at an average depth of 300 feet beneath the surface. Temporary support consisting of rock bolts and permanent lining consisting of a cast-in-place concrete were recommended. Seven intake shafts for flood water and twenty drop shafts for CSO flows would be located along the length of the tunnel. The vertical intake or drop shafts provide the means for surface creek floodwaters or overflow sewer water, respectively, to reach the much deeper 31-foot diameter tunnel. The design and location of the drop shafts was based on hydraulic input, local site conditions, geotechnical data, and other relevant information and would determine the alignment of the tunnel. Even though it would be empty a high percentage of the time, the tunnel would be designed in such a way as to minimize sedimentation. Flow velocities and shear stresses would be examined and a final grade of the tunnel determined during later stages of the GRR.

In addition to the deep tunnel, a few short levee segments and floodwalls along Mill Creek channel would be required to protect the study area to the 1% chance flood level and to prevent induced stages upstream into Butler County. Automatic gate-closures would be installed where roads cross a floodwall. Some channel modifications consisting of widening and lining with a rip-rap toe would be required in section 7. No residential or commercial structures would be demolished during the implementation of the TU alternative. Construction of the TU alternative would begin in 2007 and be completed in 2016.

TABLE 10.9.1.1
Construction Quantities for TU Alternative

Section	I-wall (lf)	T-wall (lf)	Channel Modification (lf)	Road Closures	Riffles and Trees
8	0	0	0	0	No
1	0	0	0	0	Yes
2	6,052	0	0	1	Yes
3	0	0	0	0	Yes
4	4,590	510	0	2	Yes
5	0	0	0	0	No
6	0	0	0	0	No
7	0	0	3,502	0	No
Total	**10,642**	**510**	**3,502**	**3**	**N/A**

Notes: Quantities are for construction on mainstem and tributaries

A pumping system would be required at the barrier dam to pump CSO contaminated flood flows into the MSD treatment plant. Issues relating to build up of septic conditions or potentially corrosive gases would be further studied during later stages of the GRR.

Small areas of ecosystem restoration would be undertaken near the flood water drop shafts. The previously modified sections of the Mill Creek channel would not be disturbed, except for the creation of riffles about every 500 feet to improve fish habitat and the planting of trees along the banks.

It is assumed that a Flood Warning System (FWS) will be implemented by the Corps to alert businesses and residences about a potential flood.

10.9.2 Hydrology & Hydraulics

The design of the TU alternative has required significant hydrologic and hydraulic analyses. The floodwater intake structures would be located and sized to keep 1% chance event floodwaters off all buildings and roads within the Mill Creek floodplain. For this reason, some intake structures would be located on Mill Creek itself while other structures would be located on tributaries. The most significant intake structure within the study area would be located just upstream of the confluence of Mill Creek and East Fork Mill Creek. With a total 1% chance event flow of about 6,500 cfs, nearly 5,200 cfs would need to be diverted into the tunnel at this location to keep the 1% chance flood in banks. This 6,500 cfs flow at this location includes about 5,850 cfs from Mill Creek and East Fork Mill Creek, as well as 400 cfs and 1,000 cfs diverted from an upper and lower portion of a Kemper Road Tributary. The diversion of 400 cfs would be required to prevent flooding of a commercial building upstream of I-275, while the diversion of the 1,000 cfs would be needed to prevent flooding of a motel and Kemper Road downstream of I-275. Preliminary calculations indicate that a 38-foot diameter intake structure would be needed to pass the 5,200 cfs diversion flow. As the 1,300 cfs channel flow combines with the downstream local flows, additional intake structures would be needed to prevent structural flooding. The HEC-1 computer program was used to route the remaining flows downstream, add the local flows, and divert the excess flow into the tunnel. The total tunnel flow at the Barrier Dam has been determined to be 9,700 cfs. This corresponds to a tunnel diameter of 31 feet, assuming a 75-foot head loss.

Table 10.9.3.1 summarizes the discharges that need to be diverted into the various intake structures, as well as the accumulated tunnel flows.

TABLE 10.9.3.1
Intake Structure Flows - Accumulated Tunnel Flows

Location of Intake Structures	Flow (cfs)	Tunnel Flow (cfs)
Upper Kemper Road Tributary (Mile 0.8)	400	
Lower Kemper Road Tributary (Mile 0.3)	1,000	
Confluence of Mill Creek with East Fork (Station 1962+00)	5,200	5,200
Confluence of Mill Creek with Town/UPS Tributary (Station 1905+00)	2,400	7,100
Mill Creek Up Stream of Sharon Creek (Station 1840+00)	1,200	8,100
Sharon Creek (Mile 0.66)	1,800	9,800
Cooper Creek (Mile 0.1)	2,400	11,700
Center Hill Road (Station 1422+50)		10,300*
At Barrier Dam (Station 1024+00)		9,700*

* Reduction of flow due to tunnel storage

With the above-mentioned intake structures diverting excess flows, flooding along Mill Creek, Kemper Road Tributary, and Sharon Creek should be eliminated for the 1% chance flood event within the floodplain of Mill Creek. Even with the intake structure located at the confluence of Mill Creek and East Fork Mill Creek, there would still be some residual flooding located upstream of the intake structure on East Fork. For this reason, minor channel modification would be needed to eliminate flood damages along this stream. Therefore, analysis of other tributaries to Mill Creek has been evaluated to determine if additional modifications to other streams would be required. This analysis indicates that a channel enlargement for about a 1500-foot reach would be required for a Beaver Run/Champions Tributary that enters Mill Creek near Station 1974+70. A channel modification of about a 1,100-foot reach, beginning at mile 0.575 and continuing upstream to mile 0.78, would also be needed for a Keebler Tributary that enters Mill Creek near Station 1924+70. Refer to Appendix IV for the water surface profiles for the TU alternative.

10.9.3 Environmental

Environmental restoration elements of this alternative include the planting of trees and shrubs around the surface areas of the seven floodwater drop shafts. The planting of trees and shrubs would be coordinated to complement the endemic vegetation of the surrounding area and to provide wildlife habitat and a visual screening around the shaft locations.

In-channel improvements would be limited to boulder and cobble constructions at 500-foot intervals with the previously modified sections of channel to create artificial riffles to improve fish habitat. The artificial riffle areas would provide flow modification and serve as physical water energy dissipaters under normal flow conditions. Trees would also be planted along these sections to promote riparian tree canopy development and a measure of reduction in thermal burden in the surface water of the creek due to shading, lowering the ambient water temperature.

Improvements to water quality would result from the reduction of CSOs entering Mill Creek. Seventy-four of the CSOs currently discharging into Mill Creek would be diverted into the tunnel. For storms up to a 50% chance event, the CSO would be stored in the tunnel and pumped to the MSD treatment plant near the Ohio River when the plant has available treatment capacity. For larger storm events, a substantial portion of highly concentrated first CSOs would be diverted to the MSD plant. The remaining diluted CSOs would still enter Mill Creek. The difference in water quality due to reduction in CSOs has not been determined between the TU alternative and the MSD CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002).

Additional water quality benefits could result from preventing various solvents and other chemicals used in the industrial manufacturing processes from entering Mill Creek. Protecting industrial facilities from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

10.9.4 Economics

10.9.4a Cost Analysis

The real estate costs were based on acquiring the lands and easements necessary to construct the TU alternative. In accordance with ER 405-1-12, Chapter 5, Estates, the following estates are required for real estate acquisition: Estate 1, Fee; Estate 8, Channel Improvement Easement; Estate 9, Flood Protection Levee Easement (also Floodwalls); Estate 11, Road Easement; and Estate 15, Temporary Work Area Easement. One non-standard estate would be required. The subsurface easement for a tunnel would be prepared after all requirements and restrictions have been identified. It would require approval prior to use. The estimated cost for real estate acquisition is $15 million (Table 10.9.4.1).

TABLE 10.9.4.1
Real Estate Costs for TU Alternative

Component	Acres	Unit Value	Total Value
Fee Simple			
Shaft Sites	9.2	$31,667	$291,000
Minerals [None]			$0
Timber [None]			$0
Fee Improvements [None]			$0
Easements			
Subsurface Easement	142.5	$6,455	$920,000
Channel Improvement Easement	6.7	$60,000	$402,000
Levee Easement	25.4	$58,859	$1,495,000
Road Easement	3.4	$7,500	$26,000
Temporary Work Area (Disposal)	100	$30,000	$3,000,000
Temporary Work Area (Access)	5.6	$5,000	$28,000
Subtotal – Easements			$6,162,000
Severance Damages (20% Shaft Sites)			$59,000
Total Land, Improvements, and Damages	292.8		$6,221,000
Contingency (35%)			$2,177,000
			$8,397,000
TOTAL ESTIMATED LAND COSTS ®			**$8,400,000**
Relocations [None]			$0
Administration: 670 Tracts			
Non-Federal Administrative Costs [$5,000]			$3,350,000
TOTAL LERRD			**$11,750,000**
Federal Administrative Costs [$5,000]			$3,350,000
			$15,100,000
TOTAL REAL ESTATE COSTS			**$15,000,000**

Notes: price level in 2002 dollars

The construction cost estimate for the TU alternative was primarily based on the estimate prepared by Parsons-Brinckerhoff for MSD, which was incorporated into MCACES by CELRL. The resulting cost estimate included construction; real estate; environmental mitigation; construction management; planning, PED; tunneling; and mobilization/demobilization. The TU alternative is estimated to cost $881,766,000 (Table 10.9.4.2).

TABLE 10.9.4.2
Total Cost Estimate for TU Alternative

Feature	Cost
Section 1	$28,000
Section 2	$7,686,000
Section 3	$15,000
Section 4A	$13,000
Section 4 B	$13,133,000
Section 5	$0
Section 6	$932,000
Section 7	$3,387,000
Section 8	$396,000
Tunnel	$663,292,000
Real Estate	$15,000,000
Environmental Mitigation	$0
Construction Management	$45,494,000
PED	$78,081,000
Mobilize/Demobilize	$48,988,000
Utility Conflicts	$3,610,000
Traffic Control	$1,711,000
TOTAL	**$881,766,000**

Notes: price level in 2002 dollars

Completion of the TU alternative is estimated for 2016, with the alternative base year being 2017. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2017 alternative base year is estimated at $77,063,000 (Table 10.9.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at $51,676,000. See Appendix V for detailed life cycle costs.

TABLE 10.9.4.3
Average Annual Cost for TU Alternative

First Cost	Interest During Construction	Avg Annual First Cost (2017)	Avg Annual O&M	Avg Annual Alternative Cost (2017)	Avg Annual Cost (2010)
$881,766,000	$352,604,000	$76,951,000	$112,000	$77,063,000	$51,676,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.9.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the TU alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the TU alternative was estimated at $5,188,000 (base year 2017). Table 10.9.4.4 displays the damage estimates for selected years.

TABLE 10.9.4.4
Average Damage Estimates for TU Alternative (thousands of dollars)

Year	N[15]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$39,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$48,000	$9,400	$57,400
2010		$49,800	$9,400	$59,200
2011		$51,600	$9,400	$61,000
2012		$53,400	$9,400	$62,800
2013		$55,200	$9,400	$64,600
2014		$57,000	$9,400	$66,400
2015		$58,836	$9,400	$68,236
2016		$58,836	$9,400	$68,236
2017	1	$2,888	$2,300	$5,188
2018	2	$2,888	$2,300	$5,188
2019	3	$2,888	$2,300	$5,188
2020	4	$2,888	$2,300	$5,188
2021	5	$2,888	$2,300	$5,188
2026	10	$2,888	$2,300	$5,188
2031	15	$2,888	$2,300	$5,188
2036	20	$2,888	$2,300	$5,188
2041	25	$2,888	$2,300	$5,188
2046	30	$2,888	$2,300	$5,188
2051	35	$2,888	$2,300	$5,188
2056	40	$2,888	$2,300	$5,188
2061	45	$2,888	$2,300	$5,188
2066	50	$2,888	$2,300	$5,188
Total		$144,384	$115,000	**$259,384**
Present Value (2017)		$46,321	$36,894	**$83,216**
Avg Annual Damage (2017)		$2,888	$2,300	**$5,188**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

[15] "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

Implementation of the TU alternative would eliminate the need for many of the CSO reduction projects contained in the MSD CSO reduction plan. The CSO reduction plan calls for the construction of 85 projects to address CSOs at over 100 locations. The TU alternative would eliminate the need for 74 of these projects, which would reduce the cost of the CSO reduction plan by $227 million over 25 years. No additional costs would be incurred to the TU alternative to address the CSO issue; i.e., no incremental increase in costs. Therefore, $227 million would be a cost avoided and considered a benefit to the TU alternative.

The total annual benefits of the TU alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the TU alternative, and then adding the avoided O&M and CSO reduction costs. The total annual benefits were adjusted from an alternative base year of 2017 to a project base year of 2010. Table 10.9.4.5 displays the total annual benefits for both the alternative and project base years.

TABLE 10.9.4.5
Benefit Calculations for TU Alternative

WO Alternative Damage (2017)	TU Alternative Damage (2017)	Avoided O&M Cost	Avoided CSO Cost	Annual Benefit (2017)	Adjusted Annual Benefit (2010)
$68,236,000	$5,188,000	$34,000	$8,749,000	$71,831,000	$48,169,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

10.9.4c Economic Evaluation

The economic feasibility of the TU alternative was determined by comparing the benefits and the costs (Table 10.9.4.6). The TU alternative has a BCR less than 1.0, indicating that it would not be economically justifiable. However, additional benefits (i.e., transportation) will be calculated in a later stage of the GRR. These additional benefits could bring the BCR to greater than 1.0.

TABLE 10.9.4.6
Economic Evaluation of TU Alternative (base year 2010)

Annual Benefit	Annual Cost	BCR	Annual Net Benefit
$48,169,000	$51,676,000	0.93	(-$3,507,000)

Notes: price level in 2002 dollars

10.9.5 Summary

The TU alternative completely and effectively meets the objective of providing flood reduction. An additional benefit of addressing CSOs in the creek would be realized. Similar tunnel projects have successfully been completed (Chicago, Milwaukee, and San Antonio) so the TU alternative would be engineeringly feasible. Initially estimates indicate that the TU alternative would not be cost effective (BCR <1). However, additional benefit categories will be evaluated during later stages that may make the TU alternative cost effective. Since the tunnel would be constructed 200-300 feet below grade, the environmental impacts would be minimal. Plantings in the drop shafts areas would be added for ecosystem restoration. Tunnel construction would produce limited waste and HTRW sites would have limited disturbance, primarily at the shaft sites. Acceptance of this alternative by the community and local governments would be high due to the added benefit of CSO reduction.

Based upon the evaluation to date, the TU alternative is marginal in satisfying the four evaluation criteria of the USACE planning guidelines listed in Section 2.4; namely the TU is found to be marginal with respect to "efficiency" due largely to its high cost (average annual costs are somewhat greater than average annual benefits). However, the TU alternative fully satisfies the other three criteria, and is the locally-preferred alternative. Also, it is anticipated that more benefits will be delineated (particularly sewer-backup and transportation delay benefits) during a more detailed Stage 3 evaluation.

10.10 DEEP TUNNEL 2

10.10.1 Description and Features

The TU-2 alternative was a modified version of the TU alternative. The major differences are that the tunnel in the TU-2 alternative would be approximately half the length and it would not address CSOs. The tunnel would start at the same location, but it would terminate at the previously modified channel sections at Center Hill Road. The TU-2 alternative would take advantage of the previously modified channel to provide protection up to 1% chance flood event. As in the TU alternative, the tunnel would be bored through a limestone layer at an average depth of about 300 feet beneath the surface, have a diameter of 31 feet and vertical shafts would convey creek overflows into the tunnel. Access for tunneling (removal of muck and insertion of support elements) would be performed through the drop shafts, which later would be utilized for hydraulic input. Maps showing areas of impact for the TU alternative can be found in Appendix XI. These maps should be used to estimate the impacts and alignment of the TU-2 alternative.

The benefits and costs of this plan are still under review.

11. SUMMARY

This screening-level document outlined and evaluated ten alternatives—including an economic comparison of the alternatives—and assessed preliminary social and environmental impacts based on data available to date. The evaluated alternatives include: Without-project (WO) or base condition, Total Relocation (RL), Non-Structural (NS), Non-Structural 2 (NS-2), Non Structural 3 (NS-3), Channel Modification (CM), Channel Modification 2 (CM-2), Floodwall and Levee (FW), Deep Tunnel (TU), and Deep Tunnel 2 (TU-2).

Four non-structural alternatives were evaluated (RL, NS, NS-2, and NS-3) -- providing varying degrees of flood-damage reduction. The NS-2 plan is the apparent National Economic Development (NED) plan since it provides the highest net benefits of all the plans reviewed – average annual benefits exceed average annual costs by over $29 million annually, over a 50-year planning horizon.

The CM alternative (which is very similar to the original Authorized Plan of 1970) remains economically justifiable. However, the CM alternative does not meet Corps design standards, is not environmental sustainable, and hence does not meet the criterion of "acceptability." The CM-2 alternative provides the same level of flood damage reduction (1% chance flood event) as the CM alternative, but uses environmentally sustainable engineering. The CM-2 alternative would also be economically justifiable and may be more acceptable to the public.

The other structural alternatives evaluated would provide protection up to the 1% chance flood event. The FW alternative is ineffective in that it involves 47 street closures and 19 railroad closures. This is an extremely high number of closures for floodwall/levee system, particularly along a creek where flood waters rise very quickly – hence, the plan is operationally infeasible. Also, some in the community may consider such a floodwall/levee to be unacceptable primarily from an aesthetic standpoint.

The TU alternative is the locally preferred alternative because it provides flood protection as well as reducing the problem of combined sewer overflows. The economic analysis indicated that the TU alternative has a BCR which is slightly below 1.0. However, additional benefit categories to be analyzed during later stages of the GRR may increase the benefits and make the alternative justified. A review of the benefits and costs for the TU-2 is still underway.

Table 11.1 provides a summary of the descriptions and features of the With-Project alternatives. **Table 11.2** provides a summary of the cost evaluation completed for the With-Project alternatives. The economic evaluation took into consideration the construction period of the individual alternatives. **Table 11.3** summarizes the average annual benefits and costs, as adjusted to a project base year of 2010 using a discount rate of 5.875%.

TABLE 11.1
Summary of With-Project Alternative

	Total Relocation	Non-Structural	Non-Structural 2	Non-Structural 3
Flood Control	All businesses in the 4% chance ("25-year") floodplain would be relocated and the structures would be removed. Demolish all structures to ground (grade) level and fill basements. Remove local street pavements and local service utilities (except major thoroughfares and major transmission lines).	Construct ring levees around 25 high value properties located in 4% chance ("25-year") floodplain. Ring levees would be constructed to provide flood protection for a 1% chance event, and have automatic closures. Remaining buildings in 4% chance (25-year) floodplain would be relocated and the structures would be removed.	Construct ring levees around 25 high value properties located in 4% chance ("25-year") floodplain. Ring levees would be constructed to provide flood protection for a 1% chance event, and have automatic closures. Remaining buildings in 4% chance ("25-year") floodplain would not be modified.	Construct ring levees around the 25 high value properties. The ring levees would be constructed to provide flood protection for a 1% chance event, and have automatic closures. Remaining buildings in the 1% chance ("100-year") floodplain would be relocated and the structures would be removed.
Environmental Restoration	The channel of Mill Creek would not be disturbed. Restore the bank areas with native riparian vegetation. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added).	The channel of Mill Creek would not be disturbed. Restore the bank areas with native riparian vegetation. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added).	The channel of Mill Creek would not be disturbed. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added).	The channel of Mill Creek would not be disturbed. Restore the bank areas with native riparian vegetation. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added).
CSO Abatement	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.
Recreation Enhancements	Cleared land would be available for local enhancements. Walking and biking trails would be built in sections 4, 6, and 7.	Cleared land would be available for local enhancements. Walking and biking trails would be built in sections 4, 5, 6, and 7.	None	Cleared land would be available for local enhancements. Walking and biking trails would be built in sections 4, 6, and 7.
Environmental Concerns	Contaminated material disturbed during construction would be disposed of in an appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations.	Contaminated material disturbed during construction would be disposed of in appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations.	Contaminated material disturbed during construction would be disposed of in appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations.	Contaminated material disturbed during construction would be disposed of in appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations.

	Channel Modification	Channel Modification 2	Floodwall/Levee	Deep Tunnel	Deep Tunnel 2
Flood Control	Complete modifications on remaining sections (those not improved in the 1980s). A modified channel would provide flood protection for a 1% chance event.	Complete modifications on remaining sections through the use of bioengineering techniques. A modified channel would provide flood protection for a 1% chance event.	Construct floodwalls or levees along Mill Creek to provide a flood protection for a 1% chance event. Railroad and street crossings would have automated closures.	Construct a deep tunnel to handle a portion of flood flows. In addition to the tunnel, a few channel improvements or levee/floodwalls would be required. Deep Tunnel would provide flood protection for a 1% chance event.	Construct a deep tunnel to handle a portion of flood flows in the remaining uncompleted sections of the Mill Creek channel. In addition to the tunnel, a few channel improvements or levee/floodwalls would be required. Deep Tunnel 2 would provide flood protection for a 1% chance event.
Environmental Restoration	Channel disturbances would occur. Trees and/or other vegetation would be planted along the upper banks of the entire mainstem, and the streambed would be improved for fish habitat (artificial riffles added)	Channel disturbances would occur. Trees and/or other vegetation would be planted along the upper banks of the entire mainstem, and the streambed would be improved for fish habitat (artificial riffles added)	Some work in the channel of Mill Creek would be required. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added).	Planting would occur around surface floodwater drop shafts to provide habitat as well as screening. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added)	Planting would occur around surface floodwater drop shafts to provide habitat as well as screening. In previously channelized sections of the mainstem, trees would be planted to enhance the riparian canopy, and the streambed would be improved for fish habitat (artificial riffles added).
CSO Abatement	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.	All CSOs for up to a 2-year storm event would be diverted into the tunnel and treated at the MSD treatment plant. For larger storm events, some remaining diluted CSOs would be discharged into the Ohio River.	Adverse water quality CSO issues would be addressed by MSD's CSO Reduction Alternative.
Recreation Enhancements	Walking and biking trails would be built in sections 2, 4, 5, 6, and 7.	Walking and biking trails would be built in sections 2, 4, 5, 6, and 7.	Walking and biking trails would be built in sections 2, 4B, 6, and 7.	None	None
Environmental Concerns	Contaminated material disturbed during construction would be disposed of in appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations. Areas known to have HTRWs would be avoided by stream re-routing. Impacts to wetlands would require mitigation.	Contaminated material disturbed during construction would be disposed of in appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations. Areas known to have HTRWs would be avoided by stream re-routing. Impacts to wetlands would require mitigation.	Contaminated material disturbed during construction would be disposed of in appropriate landfill. HTRW materials would be disposed in accordance with applicable regulations.	Tunnel construction would not produce a significant amount of waste (most excavated limestone is marketable as fill material). HTRW materials encountered during demolition or construction would be disposed in accordance with applicable regulations.	Tunnel construction would not produce a significant amount of waste (most excavated limestone is marketable as fill material). HTRW materials encountered during demolition or construction would be disposed in accordance with applicable regulations

Table 11.2
Summary of Costs for of Alternative Plans

Feature	RL	NS	NS-2	NS-3[1]	CM	CM-2	FW	TU	TU-2
Section 1	$8,000	$8,000	$8,000	Sec. 1-8 total = $444,859,000 (see footnote [1])	$8,000	$8,000	$8,000	$28,000	Data undergoing revision
Section 2	$17,000	$17,000	$17,000		$7,498,000	$7,498,000	$21,659,000	$7,686,000	
Section 3	$15,000	$15,000	$15,000		$15,000	$15,000	$15,000	$15,000	
Section 4A	$13,000	$13,000	$13,000		$13,000	$13,000	$13,000	$13,000	
Section 4B	$4,974,000	$8,519,000	$0		$115,820,000	$136,066,000	$27,972,000	$13,133,000	
Section 5	$0	$227,000	$0		$34,859,000	$37,446,000	$497,000	$0	
Section 6	$21,095,000	$45,442,000	$0		$107,595,000	$103,683,000	$93,536,000	$932,000	
Section 7	$95,248,000	$175,823,000	$118,147,000		$67,236,000	$234,819,000	$298,691,000	$3,387,000	
Section 8	$0	$0	$0		$12,000	$12,000	$0	$396,000	
Tunnel	$0	$0	$0	$0	$0	$0	$0	$663,292,000	
Real Estate	$497,000,000	$296,000,000	$8,000,000	$400,000,000	$48,000,000	$49,000,000	$26,000,000	$15,000,000	
Env. Mitigation	$0	$5,269,000	$7,233,000	$8,462,000	$31,304,000	$19,800,000	$49,188,000	$0	
Const. Mgmt.	$6,972,000	$12,295,000	$6,329,000	$19,745,000	$21,913,000	$27,720,000	$25,936,000	$45,494,000	
PED Cost	$11,952,000	$21,077,000	$10,850,000	$33,849,000	$37,564,000	$47,520,000	$45,661,000	$78,081,000	
Mob/Demob	$2,988,000	$5,269,000	$2,712,000	$8,462,000	$9,391,000	$11,880,000	$11,115,000	$48,988,000	
Utility Conflicts	$7,486,000	$2,635,000	$1,356,000	$4,231,000	$4,695,000	$5,940,000	$5,558,000	$3,610,000	
Traffic Control	$498,000	$878,000	$452,000	$1,410,000	$1,565,000	$1,980,000	$1,853,000	$1,711,000	
Total	**$648,265,000**	**$573,486,000**	**$155,132,000**	**$921,018,000**	**$487,487,000**	**$683,399,000**	**$607,701,000**	**$881,766,000**	
Total + IDC	$709,429,000	$649,375,000	$176,937,000	$1,039,735,000	$575,150,000	$804,767,000	$765,131,000	$1,234,370,000	

1 – Estimated quantity and cost data for the NS-3 alternative were based on comparative analysis using GIS and detailed cost data fromthe NS alternative. Therefore, it does not contain the level of detail as the other alternatives.

Notes: Price level = 2002 dollars. IDC = Interest During Construction

Table 11.3
Summary of Evaluation Results by Plan

Plan:	WO	RL	NS	NS-2	NS-3[1]	CM	CM-2	FW	TU	TU-2
A. Economic Impacts [2]										
(1) Completion Date	N/A	2009	2010	2010	2010	2011	2011	2013	2016	
(2) Total Real Estate (acres)	0	1,636	1,309	74	1,771	391	356	202	293	
- Fee Simple (acres)	0	1,636	1,309	0	1,771	54	56	0	9	
- Easements (acres)	0	0	0	74	0	337	300	202	284	
(3) Structures to be Demolished	0	413	391	4	628	121	401	11	0	
- Residential	0	322	322	0	517	116	389	11	0	
- Commercial	0	91	69	4	111	5	12	0	0	
(4) Avg. Annual Damages – residual (thousands of dollars)	$66,750	$13,043	$14,424	$24,486	$10,751	$12,257	$12,257	$12,282	$5,188	Data undergoing revision
(5) Average Annual Cost (thousands of dollars)	$0	$44,279	$40,667	$11,210	$64,997	$35,952	$50,289	$ 47,985	$77,063	
(6) Total Average Annual Benefit (thousands of dollars)	**$0**	**53,741**	**52,836**	**$42,774**	**$56,509**	**$55,395**	**$55,395**	**$55,880**	**71,831**	
- Damage Reduction Benefit (thousands of dollars)	$0	$53,707	$52,802	$42,740	$56,475	55,361	55,361	$55,846	63,048	
- O&M Cost Saving Benefit (thousands of dollars)	$0	$34	$34	$34	$34	$34	$34	$34	$34	
- CSO Cost Saving Benefit (thousands of dollars)	$0	$0	$0	$0	$0	$0	$0	$0	8,749	
(7) **Average Annual Cost– 2010** (thousands of dollars)	$0	$44,279	$38,410	$10,588	$61,390	$32,073	$44,863	$38,189	$51,676	
(8) **Avg. Annual Benefits – 2010** (thousands of dollars)	$0	53,741	$49,905	$40,400	$53,374	$49,418	$49,418	$44,472	48,169	
(9) BCR	N/A	1.21	1.30	3.82	0.87	1.54	1.10	1.16	0.93	
(10) **Annual Net Benefits – 2010** (thousands of dollars)	$0	9,462	$11,495	$29,812	(-$8,016)	$17,345	$4,555	$6,283	(-$3,507)	

1 – Estimated quantity and cost data for the NS-3 alternative were based on comparative analysis using GIS and detailed cost data from the NS alternative. Therefore, it does not contain the level of detail as the other alternatives.

2 – Price Level = 2002 dollars. Federal Discount Rate = 5.875%. Period of Analysis = 50 Years.